THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

VOL. LXXXII. No. 2093.] LONDON, JUNE 23, 1903. [55TH YEAR. PRICE 6d.

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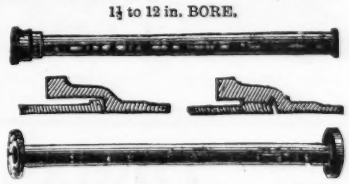

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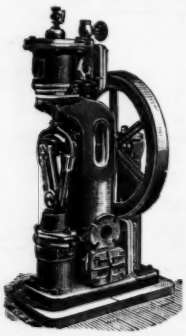

Fig. 705. "SINGLE RAM" STEAM-PUMP.

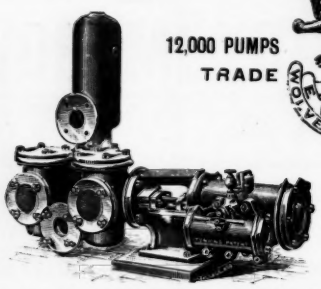

Fig. 598. "CORNISH" STEAM-PUMP FOR BOILER FEEDING, &c.

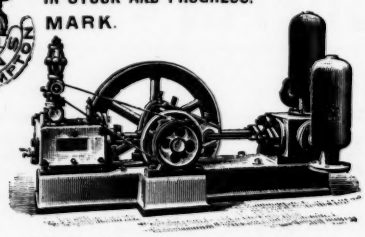

Fig. 685. "RELIABLE" STEAM-PUMP FOR TAR AND THICK FLUIDS.

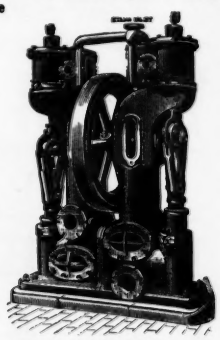

Fig. 712. "DOUBLE-RAM" STEAM-PUMP.

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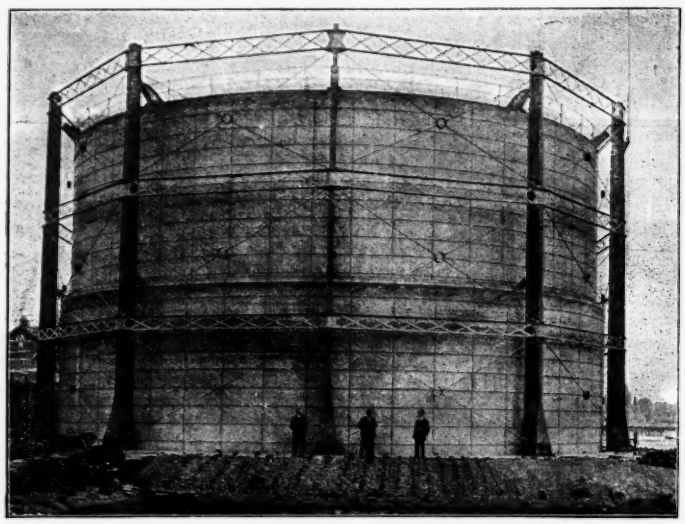

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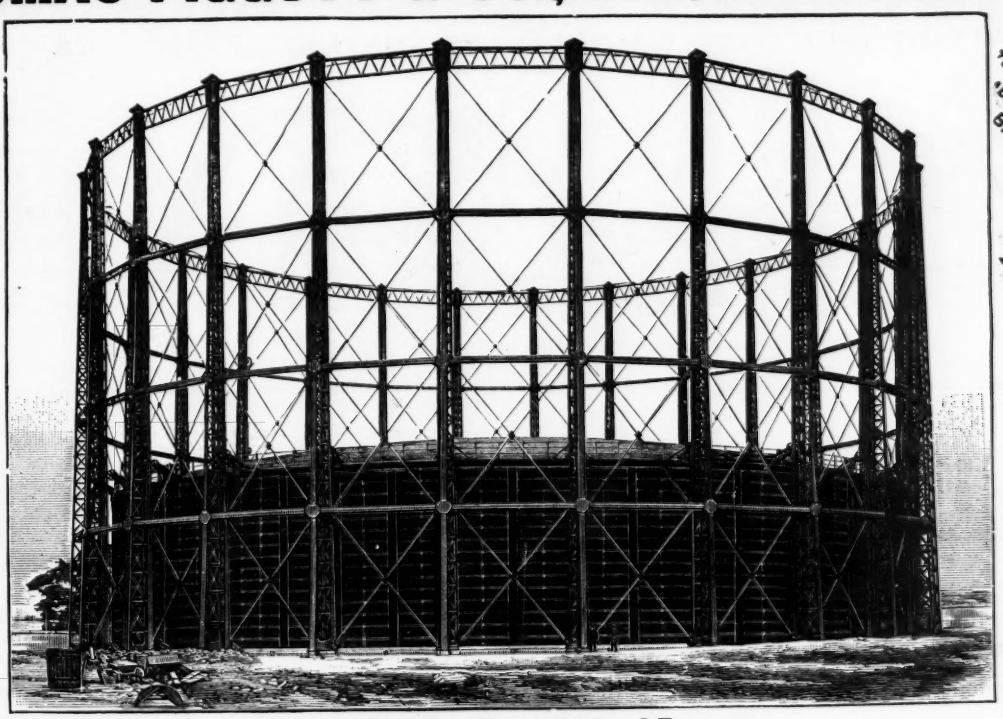

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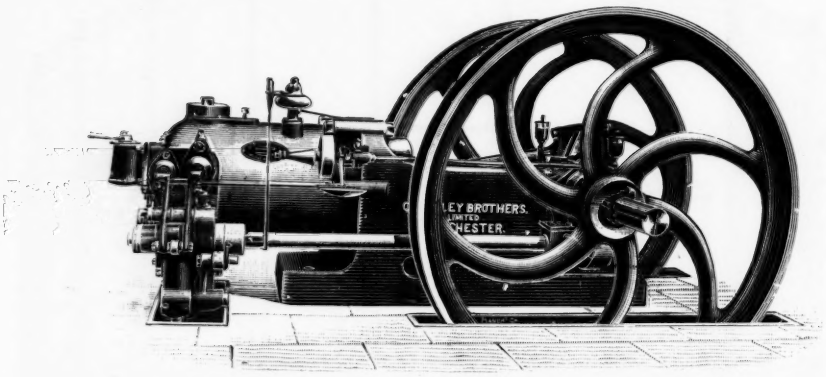

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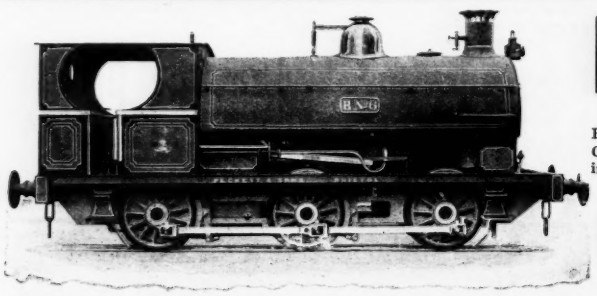

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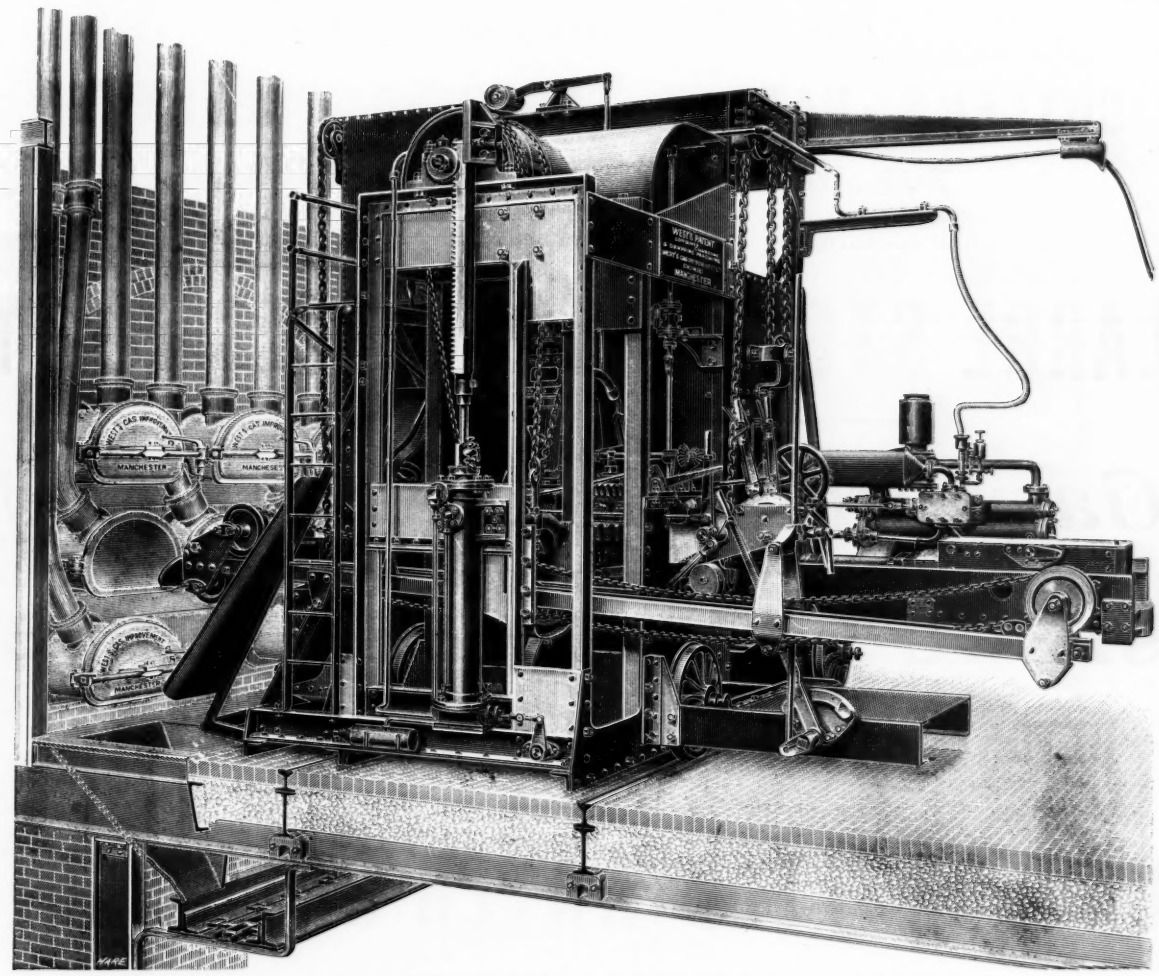

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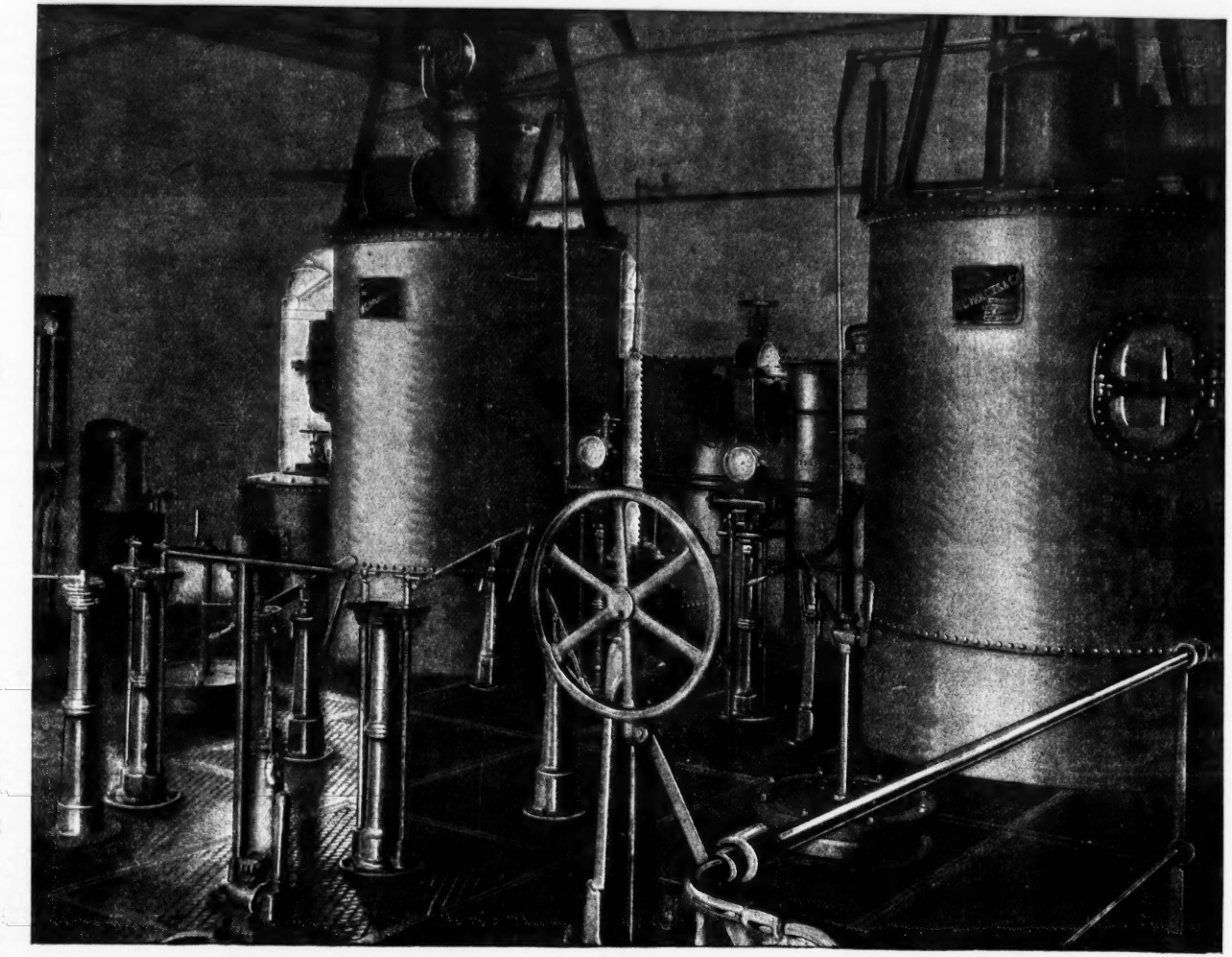

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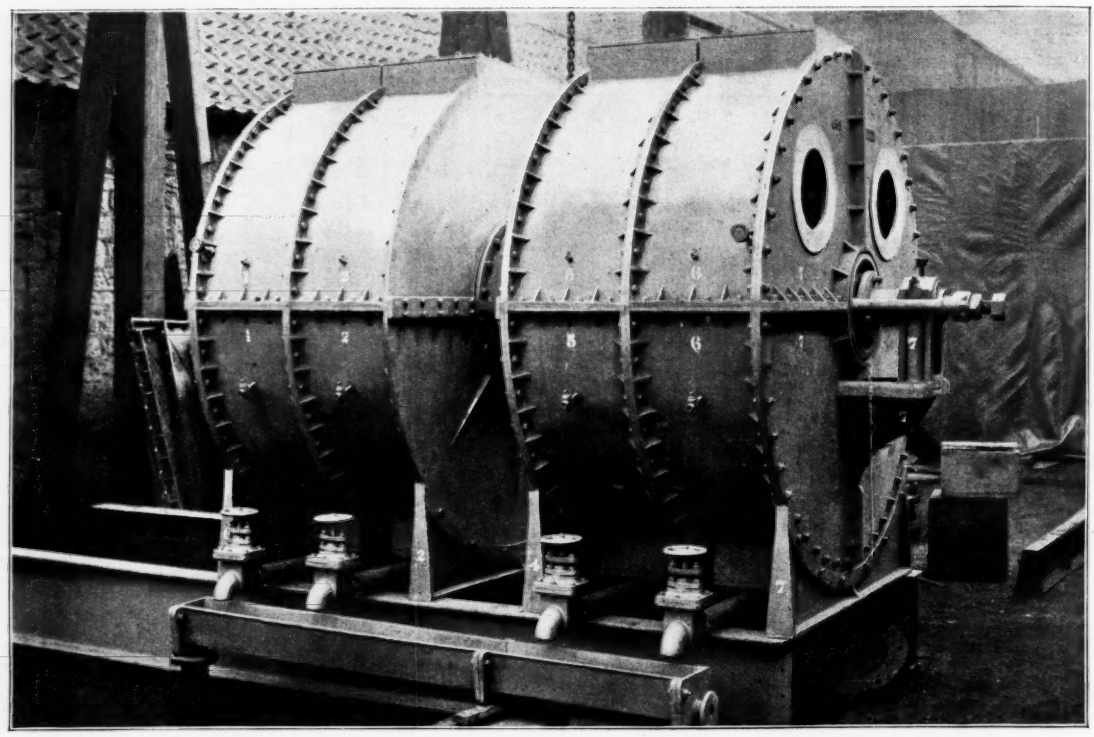

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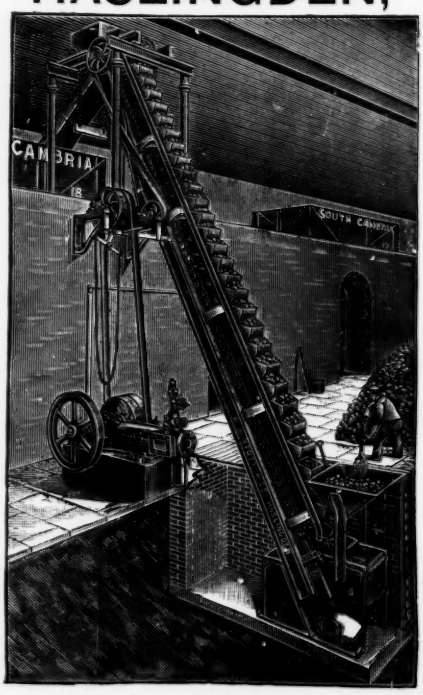

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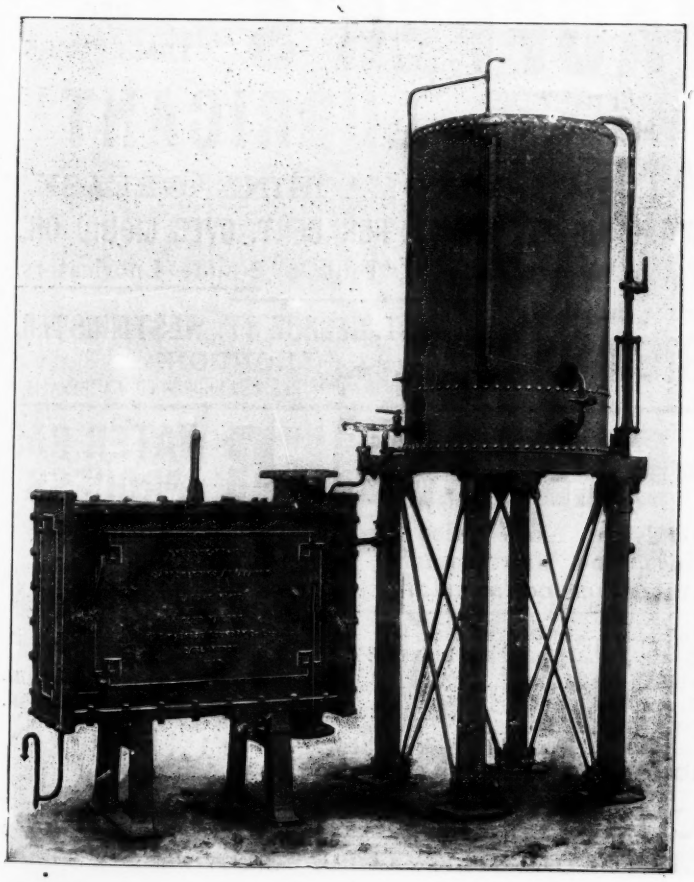

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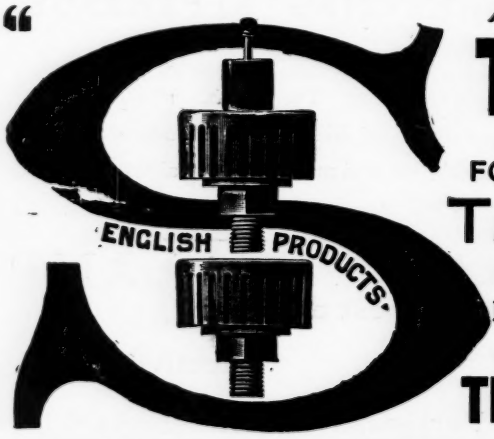

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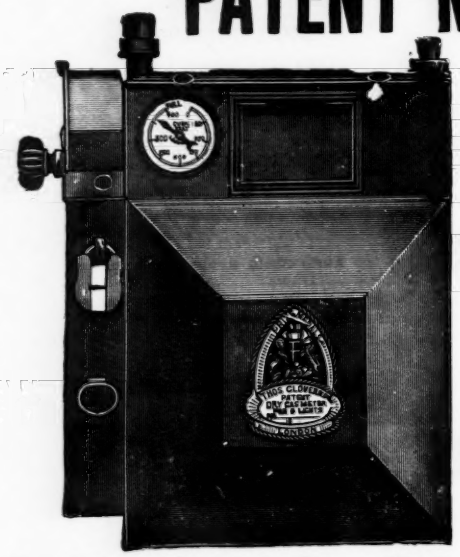

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EDITORIAL NOTES.

Radio-Activity.

IT is a very remarkable feature of the latest developments of physicial science, that they are so largely concerned with problems of light radiation. Everybody knows how the study of radiant energy received fresh impetus ten years ago by the publication of Röntgen's discovery, and its immediate application to purposes of the first order of importance to humanity generally. This discovery of light rays which more than fulfilled Sam Weller's aspirations after a means of vision capable of piercing through "a flight " of stairs and a deal door," was quickly followed by that of Becquerel, who distinguished in uranium salts the quality of emitting radiations apparently sharing the properties of both Röntgen rays and light. After Becquerel came M. and Mme. Curie, who hunted up the radio-activities of bodies accompanying uranium, and ended by discovering and isolating radium, the most astonishing of all the things of the universe that mankind has lived with from the beginning, without knowing it. The imagination of all the fanciful romancers who have written about alchemy and occultism of sorts, never compassed anything like radium. It has been classified as a metal of the calcium, strontium, and barium group, with an atomic weight which is not quite settled, and several strong and characteristic spectrum lines. This is ordinary enough. But radium differs from every other known substance in having the power to pour out *ad libitum* and *ad infinitum* radiations somewhat resembling Röntgen rays, but differing in some important points. These rays are accompanied by a temperature constantly and permanently elevated above that of the surrounding atmosphere, without any measurable wasting of the substance of the radiant. They produce obstinate wounds in the human skin; and M. Curie is so impressed with a sense of the uncanny energy of the substance, that he has declared he would not enter a room containing a kilogramme of it.

Radium in one of its manifestations is an inexhaustible light source. According to Professor Sir William Crookes, if a piece of radium salt is brought near a screen of zinc blende, which it has power to excite to phosphorescence, and the surface examined with a pocket lens magnifying about twenty diameters, scintillating spots appear. As the radium is brought nearer to the screen, "the scintillations become " more numerous and brighter, until when close together " the flashes follow so quickly that the surface looks like " a turbulent luminous sea." The merest speck of radium exhibits this phenomenon, and excites in its peculiar way substances of vastly greater bulk. The Physical Society recently held a special meeting to hear Professor Rutherford's views of radio-active matter; and then a good deal was said about the properties of thorium in this sense. He would be a bold man who should describe how thorium acts in the Welsbach incandescent gas-light. But this action, whatever it is, is merely one of the peculiar properties of thorium, as investigated by Professor Rutherford. One class of thorium rays has extraordinary penetrating power, not being stopped by several inches of iron and some feet of aluminium. These radiations, it is believed, are actually light of extremely short wave-length. If so, the remarkable point about them is that they are corpuscular—that is, solid, material substance, not ethereal undulations.

As though all this were not enough, M. Blondlot has detected another sort of rays mixed up with Röntgen radiations, which penetrate metals, are susceptible of reflection and refraction, but exert no photographic action. They were first discovered by their stimulating action on small electric sparks in air. On pursuing the search for these strangers to physical science, as in duty bound, Blondlot found them in the light emanating from an ordinary incandescent gas-burner. They penetrate various thicknesses of glass, vulcanite, paraffin, copper, gold-leaf, and even steel! They are dark. Once on the track, Blondlot followed the chase with ardour; and he was rewarded by finding the new obscure rays in an ordinary flame of illuminating gas burning without any chimney. Consequently, he concludes that they are of frequent occurrence, though invisible; and he proposes to call them N-rays, after the Nancy University, where they were discovered. He has also found that the rays can be detected by the use of a very small gas-burner, which brightens whenever N-rays impinge upon it. A fresh explanation of the brightening of one gas-flame by another! M. Blondlot seems to think this phenomenon has not been noticed before. But it has, with the result of the brightening being referred to mutual heating. This is really very wonderful. The great singularity of the new order of rays is that they seem to be amenable to all the usual optical apparatus. Their discoverer thinks they are to be located in the infra-red portion of the spectrum. They do not produce phosphorescence.

So far has the study of radio-activity brought the world of scientific seekers. Though from one standpoint it seems a long way from the state of knowledge prevailing at the period when it was taught that the undulatory forces comprised light, sound, and electricity, it is not really very far along the road which it was thought went no farther than the terminus of speculation in the law of the Conservation of Energy. All trains of thought respecting these characters of our Cosmos pulled up there for many years, according to the rule of human advancement, which is by the process of flying sap and lodgment, not by continuous progression. From time to time some man establishes himself unaided in a new position on the Debateable Land lying just beyond the Known, and is there, after a while, joined by others. Eventually, the post becomes a permanent point of occupation, with a "public elementary school" upon it; and the pioneers move onward once more. In the branch of radio-activity, the pressing forward of those who have, in a very literal sense, new lights to entice them onward, is specially noteworthy just now.

"Let There be Light."

THE conference last week in London, of men engaged in the various branches of engineering, was more eventful than was anticipated. If there is one good thing more than another about these biennial conventions of the Institution of Civil Engineers, it is that they succeed in bringing together the lights of the various divisions of the profession, many of whom are not on other occasions heard of outside their ordinary practice. The James Forrest lecture on the Monday evening gave an excellent start to the week's work. The case which the lecturer, Mr. W. H. Maw, was called upon to prove was the need of a more intimate association of the physicist with the work of the engineer; and, regarding his large and representative audience as a jury, their verdict, it was apparent, was eminently favourable to the argument laid before them. That verdict most thinkers and observers of the trend of engineering operation will be prepared to accept. The subsequent sectional work of the week also gave point and support to the necessity for tightening the bonds of the relationship; for at no time in the long history of engineering have the several branches presented so many fields which the student of physical science could explore with beneficial results for the engineer. The gas industry is not exempt. In construction, in manufacture, in the product, and in its distribution and subsequent utilization are many openings for the prosecution of scientific research.

One discussion of the week which we have reported with necessary fulness, directs the industry to more than one road in which thorough scientific investigation would be extremely valuable at this particular juncture. Royal Commissions are appointed to inquire and report upon this and that connected with the great commercial interests of the country, and reports of considerable worth are the result. There is no reason why for the general good the gas industry should not also have for the settlement of important issues their own commissions of inquiry. There is before it now a specially favourable opportunity. Quite apart from the purely and

important engineering issues with which the professional gas man is confronted, the question of the day is the supply of lower illuminating power gas; and here we have material in abundance, and a clear necessity, for a full scientific and general inquiry and report. Great interests are involved in this question; and yet the highest opinions upon it are divided. Around it leaders of the industry have, with honest purpose and belief, drawn a veil of mystification for those whose views and persuasions are purely eclectical. Taken collectively, conviction among, and information from, those leaders are as unsettled and indefinite as anything can be; and they all have their followers. In justification for these statements, we have only to direct attention to the discussion which took place on the notes presented by Dr. Rideal at the sitting of the section of the Engineering Conference in which gas had a part. The Doctor, by the way, was asked to write on "Coal-Gas Standards." His performance did not comply with the requirement. He brought within the narrow limits of the Conference rule all sorts of matters bearing upon this question of cheap and low-power illuminating gas; but with the result before us there is no occasion to censure him, though it would have been better had the notes been served up for two or three separate discussions by the same men who took part in this one.

However, our only object here (the general subject has been discussed so frequently before) is to point the practical lesson to be drawn from the discussion, and that is the need for an adequate scientific examination into the questions raised, in order to displace the manifest empiricism on the subject that exists to-day. Had Sir George Livesey been present and taken part in this discussion, he would have gone "nap" on low illuminating power gas. But of those who were present to contribute their views, we have such men as Mr. Charles Hunt and Mr. H. E. Jones on that side, and (we rather think) Mr. W. Foulis's opinion inclines in the same direction. Then we have no less authorities than Mr. Corbet Woodall, Mr. G. C. Trewby, and Mr. T. Goulden contending in the opposite direction. With such opposing forces as these, where are the men to look for guidance (and they are of the majority in the gas industry) whose rule of action in such matters, through circumstances into which we need not enter, is founded on the teachings of those at the head? The industry is prosperous and in its prosperity influential; and why should not the industry appoint its own Commission to inquire into the several questions which are to be found embedded in the mass of discussion last Thursday, and some of which the scientist can best settle? On those questions further light is clearly urgently required. The way to obtain it seems plain; and its value would be great.

There are two or three subjects other than the one already referred to which claimed consideration during the conference, in which gas men are interested, and notes of the proceedings in connection with them will be found elsewhere. There is also one general point to which we would call the attention of the Institution authorities; and it may be put in the form of a question, Would it not be possible, instead of having a section for water, sewerage, and gas to, at future conferences, divide it, and have a section for water and sewerage and another for gas? The present combination brings about a condition of affairs that does not offer much inducement to gas members to journey to town from the Provinces. There was really only the one paper in the gas section which immediately appealed to them; and there must certainly be a greater and more varied attraction than this to make the conference successful in point of attendance so far as gas engineers are concerned.

The Cost in Fuel of a Unit of Electricity.

As bearing upon the question of the price at which motive power can be profitably distributed, which is just now exercising the minds of our readers who are managers of gas-works supplying manufacturing towns, particular attention should be bestowed upon some highly significant statistics as to fuel consumption just published on the authority of Mr. Faraday Proctor, the Engineer of the electricity supply undertaking of the Bristol Corporation. Among the other interesting data contained in Mr. Proctor's last annual report, are the actual figures of the coal consumption at the central station, and the cost, per unit of electricity sold, for every year from 1895 to 1902 inclusive. Beginning with a consumption after the rate of 18·75 lbs. per unit in the former year, costing 0·97d., the weight came down to 12·37 lbs., costing 0·83d., in 1900. This was the lowest point reached. Last year the figures were 12·88 lbs. per unit, costing 0·91d. It is evident from these data that the economy of the method of generating mechanical power for distribution employed in this example leaves a good deal to be desired. From whatever point of view the facts are regarded, it cannot be maintained that the result is satisfactory. Of course, it may be alleged that the working of this particular undertaking is bad; but, without some very conclusive evidence, this is an aspersion that cannot be accepted as justly founded. The Bristol electricity generating works, one would presume, are in all probability neither better nor worse than others of which the managers are more reticent of their results. The progressive reduction of the fuel consumption per unit sold is an indication of an improving business, up to a point, and of careful management throughout. The load-factor is nearly 14 per cent., which is fairly good—indeed, there are few similar establishments that show a better. The capacity of the plant is also fairly large, being about 5000 kilowatts; and it is quite first class of its kind. The generating plant in question is composed mainly of Lancashire steam-boilers, with machine stoking. The engines are Willans compound, with one turbine, surface condensing. Yet, with all these advantages, the net result is as stated. Moreover, it is not improving. The example is not cited for the purpose of pointing to the existence of anything defective in the plant or the system itself, which, as has already been remarked, are probably fairly typical. One is driven to ask, however, whether, on the face of the figures given, this is a means of distributing power creditable to the principle embodied in the system. Does it appear to offer any promise that a trade in power distribution can be built upon such a method of operation?

The foregoing question is independent of the price at which the Bristol Corporation choose to offer electric power in the city. That is a matter for themselves, and chiefly concerns the citizens and the Bristol Gas Company. The Corporation may offer their electricity at nothing per unit, if they please, without altering the general truth that a system which consumes fuel at the rate ascertained in this case is economically bad. Something was said at the Engineering Conference last week about the fuel consumption of electric power generating units; but actual works results are worth all the talk in the world about the possibilities of steam-power generation under test conditions. Though the truth escaped recognition for a time, as in the leading case of the Birmingham Compressed Air scheme, which was to have worked such wonders of economy, the failure to realize any saving of fuel at the power station eventually wrecked this project. If the great majority of the electric power generation schemes now in course of exploitation in the kingdom—including those connected with electric lighting undertakings—prove disappointing in the long run, it will be through their inordinate demands upon the coal pile. This is far from being the first time that the actual extent of the discrepancy between fancy and fact in steam electricity generation has been exposed. Such keen and candid observers as Hopkinson and Ayrton dwelt upon the matter, and laid stress upon its extreme gravity, years ago; and all that is novel in the present notice is the testimony that the defect still persists.

Gas Lighting, Hygiene, and Spring Cleaning.

Various observations of contemporary facts connected with the subject have comforted the friends of gas lighting in regard to those familiar objections once so freely taken against this means of illumination on hygienic grounds. It used to be a commonplace of professors of scientific views of questions affecting public health, that if the burning of coal for heating, and of gas for lighting, interiors could only be done away with by the introduction of the cleanly and innoxious electricity, all the troubles about ventilation would disappear, and the enormous saving in cleaning, painting, and whitewashing would pay for any increased cost entailed by the change. Alas for preconceived ideas! Such a change has indeed been effected in sufficient variety of examples to test the expectation, only to show that, where people congregate in large numbers, though coal and gas may be banished, the dirt remains, and the need for ventilation is as great as ever. The most striking example in point is the case of deep-level electric railways. While the atmosphere of a railway tunnel with steam locomotives fired with

the best smokeless coal procurable leaves a good deal to be desired, quite as much objection is taken on other grounds to the air of the Central London "tube" line. Travellers by the latter during certain hours of the day have good reason to regret the lack of a dash of sulphurous acid in the mixture they are constrained to breathe. Chemical science, competent as it is for analyzing most substances, fails to identify the source of the peculiar vileness of anything which is simply fœtid. The characteristic aroma of the "tube" railway during business hours eludes the test-tube.

As regards the effect of "cleanly" lighting and warming arrangements upon the wall and ceiling surfaces of interiors, the members of the new Institution of Gas Engineers who attended the recent meeting in the lecture hall of the Institution of Mechanical Engineers had before their eyes an object-lesson which they are not likely to forget. The hall is fitted with steam radiators at intervals round the sides; and over every one of these there was a huge stain of sootiness as pronounced as ever marked the position of a "dirty" gas-burner. The phenomenon is not an exceptional one; but it was very well exhibited in this instance, as though to indicate to all beholders the continuing necessity for "Spring "cleaning" under all conditions of heating and lighting. Not to put too fine a point upon it, steam heating and the electric light did not prevent the hall of the "Mechanicals" from exhibiting a notably dirty appearance. The ventilation of the hall, by the way, is a matter of draughts distributed impartially all over the interior; so that, in the opinion of the responsible authorities, the necessity for a constant change of air is independent of the method of lighting. It would be much more comfortable if the process were less obviously energetic.

The Proposed Widened Scope of the Institution.

Of the seven suggestions thrown out by the President of the Institution of Gas Engineers, in his Inaugural Address, for enlarging the scope of useful work of that body in the future, the first is one to which the thoughts of a good many members of the gas profession will be directed in the course of the current year, apart from the members of the Committee who will be appointed by the Council of the Institution to consider it. The advisability of bringing about the affiliation of the District Associations with the central body has been more or less discussed from time to time, but the existence of late years in London of two bodies devoted to the gas industry has caused the subject to remain in abeyance. Now, however, that there is once more a united organization, a better prospect is presented for the realization of the idea. It is, of course, by no means a new one; and it was not put forward by Mr. Dougall as original. In fact, the subject was broached nearly a quarter of a century ago, as we are reminded, by Mr. W. J. Warner, of South Shields, in the course of his Inaugural Address at the meeting of the British Association of Gas Managers in Newcastle-upon-Tyne in 1879. Mr. Warner urged that the organization, as it then existed, was not adapted to "develop to the fullest the collective knowledge and experience of the profession," and make available, for the common good, the opportunities for observation which the members possessed; and he suggested that its advantages required supplementing by local knowledge and experience, which would be furnished by the District Associations. The portion of his address bearing upon this matter will be found in our "Correspondence" columns; and it will doubtless be read with interest.

Steam-Rollers

An old question was once more raised in the course of an action tried recently by Sir Horatio Lloyd at the Wrexham County Court. The dispute was as to the liability for damage done by a gas explosion which arose through a broken main. The facts of the case were simple, and the amount claimed was trifling; but the principle involved was of first-class importance, alike to the Wrexham Gas Company and to other gas and water supplying concerns. The essential point raised was, indeed, with regard to the proper depth at which mains should be laid in the public streets. Now as it happened, Sir Horatio Lloyd was peculiarly well fitted to deal with this matter, seeing that some three years ago the same question was argued fully before him in connection with actions brought by the Denbigh Gas and Water Companies against the Corporation for damage caused to their mains through the use of a steam-roller. In that case, his Honour held that, though no negligence had been suggested in the use of the steam-roller by the defendants, who were simply employing a lawful and acknowledged instrument, they were liable for injury resulting from its use, unless the plaintiffs had been guilty of negligence in the laying or the condition of their pipes. He made it quite clear that the point to be decided was whether the pipes were laid at a sufficient depth to be protected from the ordinary traffic of the district at the time they were put down; for, as he said, the Companies could not be expected to alter their systems, and relay their pipes at a greater depth, because steam-rollers, which might be of a continually increasing weight, were from time to time introduced. The fact that the pipes had withstood injury for many years—the breakages complained of having all occurred after the arrival and use of the steam-roller—was to his mind sufficient proof that they had been laid deep enough to bear any traffic but that occasioned by the unforeseen employment of heavy steam-rollers. He pointed out that those who used highways must do so with due regard to the rights of others lawfully using them; and bringing upon the road an unusual and extraordinary load, however lawful, carried with it liability if the property of others was injured. Under these circumstances, his Honour found the defendants liable; but he was not satisfied that the Denbigh Water Company (whose action was taken first) were entitled to all they claimed, because it was not clear, owing to the insufficient depth at which some of the pipes were laid, that the breakages might not have been caused by the ordinary traffic of the district, apart from the steam-roller. Their claim was therefore disallowed in respect to certain of the breakages.

And the Depth of Gas and Water Pipes.

Applying this judgment to the Wrexham case, Sir Horatio Lloyd explained what he considered a proper depth for the pipes to be laid at the time they were put down—namely, twenty or thirty years ago. At Denbigh he held, as the result of expert evidence, that a depth of 18 inches was sufficient, and the breakages in regard to which he disallowed the Water Company's claim occurred in pipes placed from 14 to 16 inches below the surface of the ground. In the Wrexham case, the depth of the pipes was 18 inches, which was precisely the limit of safety which he had previously fixed. There was no alternative, therefore, but to adhere to the earlier decision, and find that the Wrexham Gas Company had not been guilty of negligence in laying their pipes a quarter of a century ago at a depth of 18 inches. His Honour was again particularly careful to emphasize the fact that the question to be decided was whether the pipes were laid at a sufficient depth having regard to the state of the traffic upon the road at the time they were put down. At that date, there were no ponderous steam-rollers dragging their huge weight over the surface of the roads, such as are to be seen to-day in almost the smallest streets of the most insignificant towns and villages. Even authorities who have not yet seen their way to become the actual possessors of a steam-roller, now get their roads repaired with the aid of a "monster" hired from some one or other of their more fortunate neighbours; and so gas and water pipes everywhere are subjected to a pressure which they were never expected to have to bear. It is impossible to disagree with the law laid down by his Honour—that when a gas company acting under statutory powers have laid pipes under streets at a sufficient depth for the existing state of traffic, or the traffic which might reasonably be contemplated, they have done their duty, and are not bound to take up the streets to lay fresh pipes because somebody else chooses to bring in a much heavier vehicle. Fifty tons was the weight named for this "heavier vehicle" by his Honour, for the sake of argument; and perhaps it is not impossible, having regard to the developments of mechanical traction, that such a weight may at some future time be actually attained. Gas and water companies are not, however, bound to look so far ahead as this. All they have to do is to have proper regard for existing traffic, and that which may reasonably be contemplated; those introducing new inventions in the shape of heavier vehicles must do so at their own risk. The steam-roller is now an accomplished fact; and therefore it does not necessarily follow that what was a reasonable and proper depth to lay

pipes thirty years ago would be considered sufficient for mains put down, in the light of later knowledge, at the present day. For their own sakes, gas and water companies are likely to place their pipes deep enough to protect them from any pressure which it is probable may be brought to bear upon them under ordinary conditions. It is with respect to pipes laid long ago that this trouble of steam-roller breakages usually occurs.

Twelve Thousand Cubic Feet per Ton.

It has for some months been an open secret among gas engineers in the South-West that something was going on at Exeter. Rumours of high results and other interesting matters have served to excite some curiosity, which the information published in the "JOURNAL" last week and this will go far to satisfy. Messrs. Settle and Padfield have been working at their process for several months; and in order to have some independent expert evidence as to its value, they decided to call in the services of Mr. Norton H. Humphrys, of Salisbury, to make a trial of its capabilities. The results of the test, together with some considerations suggested by it, are reproduced in another column; and they certainly warrant the tests that are promised on a substantial working scale. A high make of gas per ton, an improved coke, the utilization of cheap small coal, the avoidance of nuisance, &c., are matters of vital interest as regards the future of the gas industry. The new process leaves the engineer an almost unlimited range in respect to introducing coal or removing coke, and therefore of varying the quality of his products to a degree that has hitherto been unheard of. Mr. Humphrys' notes appear to give promise of further information at a future time, and convey the idea that several points other than those particularized are under investigation. These details will be awaited with much interest.

A Question of Notice.

A point of some importance to employers of labour was decided last week at the Chichester County Court, when the Corporation were sued by one of their former workmen for 18s. wages in lieu of notice. It appeared that plaintiff was engaged as a weekly servant, and was paid every week. A Committee of the Council went into the matter of the general employment of their workmen; and they drew up a number of rules. One of these was to the effect that any workman more than five minutes late should be suspended for a quarter of a day; and another that the Corporation were to retain in hand three days' pay due to each man, so that when the rules came into force the workman was only to receive half a week's pay. The new rules were posted up outside the pay office on Saturday, May 2. The plaintiff, however, said he did not assent to the alterations; and certain of the men, including himself, sent a "round robin" asking the Committee to reconsider the matter. On the following Saturday, the Surveyor informed the men that the Committee had refused to modify the rules, and they must either sign the register to comply with the new rules or leave. The plaintiff did not sign the regulations; but he presented himself every morning during the next week, and asked to be set on to work. He was not, however, allowed to start again. Under these circumstances, he maintained that he had received no notice to terminate the contract of service which he had entered into with the Corporation, and that it was not within a master's right to alter the terms of the contracts with his servants without due notice to them. Judge Martineau said that if a man was told he might work the following week on the old terms, but that afterwards he must work under the new regulations, this was as good as giving a week's notice; but in reply to this it was suggested that the week referred to must be treated as one of negotiation between employer and employed. The City Surveyor stated that for some time the Labour Committee of the Council had been dissatisfied with the way in which the work was carried out, and the irregular hours worked by each man. He went through the new rules and explained some of them to the men. He told them there was a register for them to sign the following week; and if any man did not see his way to sign it, he would be paid his money. It was therefore contended on behalf of the Corporation that notice to terminate existing contracts was given on May 2. His Honour agreed with this view, and held that the request to sign the register was equal to, if not stronger than, a week's notice. He consequently gave judgment for the defendants with costs. By this time the workman in question will probably have realized how injudicious he was to bring forward such a claim. On the other hand, the Corporation—in spite of the remark of his Honour that such bodies had no consciences—were fighting for the establishment of a principle; and their success may possibly be of some assistance to others who may be similarly situated in the future.

The Question of Mantle Licences.

On more than one occasion of late, we have been asked to call attention to the subject of the mantle licence, in view of the fact that there has been little honourable compliance with the terms of the bargain. We have, however, hesitated to make more than an incidental allusion to it, as it has appeared to us to be entirely a question between the Welsbach Company and those who choose (we use the word deliberately, as there are but few who do choose) to pay the royalty under the licence. But now a correspondent who holds a high position in the commercial gas world, moved by the appeal made by Sir George Livesey to the guarantors of the fund which produced the settlement of some fourteen months ago, has written us a letter on the subject; and it appears in the "Correspondence" columns to-day. For reasons which, in our judgment, are sufficient to warrant compliance with the request the writer made, the letter is published under a *nom de plume*. It is common knowledge now that there are few among the mantle traders who are paying royalty to the Company; and why? Our correspondent explains; and we will state the main point shortly. The fundamental principle of the bargain entered into early last year was that there should be protection for the licensees against those who were trading or thereafter commenced to trade in mantles without licences, and whose mantles could be held to infringe the patent of 1893. But the neglect of the Company to give protection by prosecuting actions against dealers in unlicensed mantles has knocked the bottom out of the agreement; and hence the cessation of the payment of royalties by several who put their signatures to the agreement in the spring of last year. We know, and gas engineers know, that there is an absolutely free trade being done to-day in unlicensed mantles; and further, that mantles are being sold stamped as "licensed" upon which not a fraction of royalty is being paid. Moreover there are gas companies and committees who, believing they are doing their part in upholding the honourable agreement made twelve months or so since, will not purchase anything but mantles marked "licensed." Did they but know how meaningless in some cases the word is, they would evince less anxiety over it. In all friendliness, we ask the Directors of the Welsbach Company whether the position is fair to the few dealers who have remained faithful to their agreement, notwithstanding the facts that trade in mantles on which no royalty is paid is proceeding with increasing vigour, and that there is no indication of any attempt being made to prevent the violation of the 1893 patent and the settlement? In the present position of matters, the bargain is (if there can be such a thing) a one-sided affair; and we submit that, if there is not going to be full protection, then there should be open renunciation of all claim to royalty.

The Hygienic Aspect of High-Pressure Lighting.

A specially interesting contribution to the discussion on the three papers on high-pressure incandescent gas lighting read at the meeting of the Institution of Gas Engineers was made by Mr. G. Stevenson, the Secretary and Manager of the Long Eaton Gas Company. He has made a "forward movement" in the direction of improving the lighting of certain lace factories in the town by the introduction of the high-pressure incandescent gas system, and has now very nearly 400 lights in use, having a total illuminating power of about 120,000 candles. This is a highly satisfactory result; but, as he told his colleagues at the meeting, it has brought trouble with it. Complaints were made of workpeople being rendered ill by the new light; and, of course, these were at once made use of by the electricians, who talked about carbonic oxide poisoning. However, Mr. Stevenson was not to be scared from his position; and so he looked into the matter, and came to the conclusion that a large increase in the quantity of carbonic acid in the atmosphere of the shops was really at the bottom of the mischief. His Directors very prudently determined to have a thorough investigation; and they secured the

services of Mr. W. J. A. Butterfield, M.A., F.I.C., F.C.S., for the purpose. Those who attended the meeting had an opportunity of glancing through this gentleman's report, a copy of which Mr. Stevenson had with him. Others to whom its contents may be of interest will be able to make themselves acquainted with their nature from the portions which we reproduce in another part of the "JOURNAL." The conclusions Mr. Butterfield arrives at are that "electric lighting has no hygienic advantage over high-pressure gas lighting in lace factories, if such means of ventilation as may reasonably be required in all cases are provided;" and he points out that this system of gas lighting really lends itself readily to the improvement of the ventilation of shops without introducing perceptible draughts. In the course of Mr. Stevenson's remarks, he referred to the report of the Departmental Committee on the "Ventilation of Factories and Workshops." Mr. Butterfield also does so; and its perusal—or, at all events, the articles upon it which appeared in our columns at the time of its issue—may be commended to our readers in conjunction with the one to which their attention is now being specially directed.

Holidays on the Cheap.

Our commercial friends of the gas industry may rejoice to know that the annoyance to which they are subjected by appeals for contributions to provide for the holidays and enjoyment of their customers' employees is experienced by firms in other industries. If, however, they do not find any pleasure in the knowledge of this fact, then they may feel a little sympathy for some of their fellow-sufferers, who, under the heading of "A New Form of Impudence," have been giving vent to their resentment recently in the columns of the "Standard." To one of the writers, the begging application appears to be "quite a new departure," which is proof positive that he does not trade in the gas industry. He appends to his protest a copy of the begging letter, which for its "cool impudence" he says surpasses anything that has yet come in his way in respect of requests for subscriptions. This letter may be useful as a copy for some of those who have lost their self-respect in the gas industry. Here it is: "Sir, we, —— and Co., builders, are this year holding our workmen's outing at Bournemouth. May we presume to ask you for a subscription towards the expenses of same, which may be sent to the Secretary of the firm at his private address? This being the only outing the men get together this year, we hope you will be able to help us to make it a success. Thanking you in anticipation of a favourable reply." A hop merchant also writes: "At this time of year, we daily receive letters from the employees of different firms asking for a contribution towards outings, cricket, football, and rifle clubs, &c.; and of one firm the clerks had the impudence to write and ask our help towards a wedding present they wanted to give to one of their staff! This custom is becoming such a growing nuisance that it ought to be put a stop to by the heads of firms. If we do not comply with these requests, we are in their [the clerks'] power to do us some harm with their principals." There is the difficulty; and we hope the chiefs of gas-works will note it, and prevent any miscarriage of justice through the misrepresentations of subordinates within their own walls.

WATER AFFAIRS.

Increased Water Storage for London.

To an ordinary conversationalist, there would doubtless appear to be a certain amount of inappropriateness in introducing at the present time such a topic as the disastrous effects of long-continued drought. And yet the subject would not be altogether incongruous; for closely allied to it is the question of making provision for meeting such emergencies by conserving the redundancy of one period to compensate for the deficiency of another. Only a few years ago, owing to an exceptional spell of very dry weather, the inhabitants of the East End of London had to suffer some inconvenience—much less, however, than people tried to make out—in consequence of the substitution for a few weeks of an intermittent for a constant supply of water. The result was that the Directors and officials of the Water Company responsible for maintaining the service in that part of the Metropolis had to sustain all the opprobrium which local public bodies and the Press did not fail to heap upon them. A good deal was then heard about the "shrinkage" of the Thames and the Lea, due to the pumping operations of the London Water Companies. It would be interesting to hear what the residents on or near the banks of these rivers would say now in opposition to a proposal for an extension of those operations; for they have been considerable sufferers from the abnormal meteorological conditions which have lately prevailed. During the past fortnight, there has been a fall of rain such as has not been experienced, according to Mr. Sowerby Wallis and Dr. H. R. Mill, for five-and-forty years—no less than 3½ inches descending in 58½ hours from midday on the 13th to 11.30 p.m. on the 15th inst. An inch of rain falling over an acre of surface corresponds to a volume of 22,400 gallons; and as the greater portion of the 3½ inches referred to fell in the valleys of the Thames and Lea, it is not surprising to find those rivers in flood, and damage to property resulting.

The question that naturally arises in connection with such visitations as the present is whether some measures could not be adopted for relieving the swollen rivers of a portion of their contents. Reference has been made by "The Times" to the great barrage works which Sir John Aird's firm have so successfully carried out on the Nile; and the suggestion has been thrown out that something similar might be possible for dealing with the waters of the Thames. The feasibility of such a proposal is a question for the civil engineer. But, whether it is practicable or not, there is, at all events, one way of partially meeting the difficulty, and that is by the construction of additional storage reservoirs. We confess to having always agreed with those who have thought that there is to be found at no great distance from the Metropolis enough water to supply the needs of its inhabitants for many years to come, and that consequently there is no immediate necessity to undertake a gigantic scheme for bringing water from Wales. The "silver-streaming Thames," about which Spenser sang, and which many another poet since his day has apostrophized, has, on the whole, been a bountiful source of supply, which, notwithstanding occasional "shrinkage," we do not think is likely to fall off to any serious extent. What appears to be wanted is some scheme for relieving the stream of its redundant water, and utilizing it for human consumption.

Of course, there is nothing new in the idea of having storage reservoirs in the vicinity of rivers. Many are already in existence in the valleys of the Thames and Lea; and the past week witnessed a further addition to the number. On Monday, as will be seen by the report which appears elsewhere, the Chairman of the much-maligned East London Water Company—Colonel Lockwood, M.P.—presided at the ceremony (performed, curiously enough, in most inclement weather) of formally opening the two high-level reservoirs, named after himself and his predecessor, which, in the face of much opposition, the Company obtained power some five years ago to construct. They cover an area of 164¾ acres, and have a total capacity of 1198 million gallons. The Company have now in the Lea Valley twelve storage reservoirs, which, when full, have a combined area of 479 acres; and they will hold 2400 million gallons. This is indeed a large store of water; but it is small in comparison with that of the two magnificent artificial lakes which the members of the Engineering Conference had an opportunity of seeing at Staines on Wednesday, under weather conditions which were in striking contrast to those prevailing two days previously. These reservoirs, which may be almost regarded as one, have a combined water area of 424 acres, and a capacity of 3338 million gallons. Here it may be pointed out that they are only the first instalment of a very comprehensive scheme, which was submitted to Lord Balfour's Commission, for the construction of nine large reservoirs upon land in the neighbourhood of the above-named town. The Commissioners expressed unqualified approval of it, more particularly because it could be carried out in sections, as required. Since then, however, an event has happened which will have an important bearing upon the future water supply of the Metropolis. Whether the new Board who will soon be responsible for it will consider the scheme is adequate to meet the demands of the population, or will be content with nothing short of an entirely new supply from Wales, time alone will show. But, whatever they may decide, the two latest additions to the existing works will prove valuable auxiliaries in ensuring to the inhabitants of the Metropolis for some years to come an amply sufficient supply of water for all reasonable requirements.

THE

INSTITUTION OF GAS ENGINEERS.

PROCEEDINGS AT THE FIRST ANNUAL GENERAL MEETING.

HELD AT THE

INSTITUTION OF MECHANICAL ENGINEERS, WESTMINSTER, S.W.

JUNE 9TH, 10TH, AND 11TH, 1903.

Mr. ANDREW DOUGALL, President, in the Chair.

PAPERS READ.

HIGH-PRESSURE GAS INCANDESCENT LIGHTING.

By WILLIAM SUGG, of London.

At the meeting of the Gas Institute in June, 1901, the writer gave a paper on "High and Low Pressure Gas Incandescent Lighting," illustrated by drawings of the burners and the pressure-increasing apparatus as it then was. Since that time, considerable improvements have been made in the system of lighting; and I propose in this paper shortly to describe these improvements.

Drawing No. 1 shows the original pressure increaser driven by hydraulic pressure, such as is used, among other places, at the Great Central Station, at Euston Station, and at several other railway stations. Drawing No. 2 shows the writer's improvements on No. 1 water-engine.

Since the meeting in 1901, the Tower Bridge, Blackfriars Bridge, and London Bridge have been lighted by incandescent gas—the two former with high pressure, and the latter with low pressure; also Bristol Joint Station of the Great Western and Midland Railways, York Station of the North-Eastern Railway, and a number of other railway stations, engineering factories, and lace factories, &c., with high pressure—the writer's improved water-engine being used. Now these installations have necessitated a special arrangement both of burners, reflectors, and pressure-increasing apparatus to satisfy the different requirements. For example, in engineering factories the vibration of the machinery was found very destructive to mantles, and, consequently, it became necessary to provide means by which this excessive vibration might be counteracted. This has been effectually done by means of the suspension light shown in Drawing No. 3.

For many shops and mills where there was a nearly regular running shafting, some of the pressure increasers were arranged to be driven from the shafting; and a by-pass arrangement was devised, so that when any of the lights were put out, the pressure was not increased, or when the number of the lights was increased, according to the requirements, the pressure was not reduced. This is found to be a very economical way of raising the pressure; the only drawback to it being that if the machinery stopped, the light stopped also. In order to obviate this objection, the writer devised a new engine (see Drawing No. 4), which would automatically supply all the burners in the factory with the proper quantity of high-pressure gas required at any moment, and by which the inconvenience of the valves which were used in the first-mentioned engines sometimes sticking and chattering, is done away. The engine regulates its speed by means of a simple form of governor as shown in Drawing No. 5, so that it can supply from the one light to its full number of 300 or more 10-feet burners automatically. When all the lights are turned off, it stops.

The engine and the pump are both fixed upon one base-plate; the two steam-cylinders working without valve-slides or connecting rods, driving one crank common to the three cylinders. The crank is provided with a fly-wheel, so that the revolutions of the engine are kept perfectly steady. The valves, both of the engine and gas cylinders, are face-valves provided with a centre-pin on which the cylinders move; and by means of the oscillation of the cylinder caused by the motion of the crank, the valves are opened and closed. Consequently, they work with the smallest amount of friction. The pressure of both gas and steam tends to lift the cylinders, and thus reduce the friction on the valve surfaces. The action of the pressure increaser is silent. At the same time the valves, being under the cylinder, let out any condensed water from the steam which accumulates when the engines are working slowly or stop. The engine therefore starts itself whenever one or more lights are turned on, supplying the quantity of gas required without any attention. The requirements of some engineering shops and lace mills are such that it is not convenient to work off the boilers which drive the machinery of the mill; and so it has been found necessary to provide a separate engine, so that the lights are kept burning though the engine of the mill or workshop is stopped. This has been done by means of the engine just described. But for some of these places, it is better to use a gas-engine; and this has been done by a combination of gas-engine, with a pressure increaser designed by the writer, and shown in Drawing No. 6.

In the case of the Tower Bridge and the Bristol Joint Station of the Great Western Railway, the water-engines shown in Drawing No. 2 were found to be very convenient, because they started and stopped themselves without attention, as does also the steam-engine shown in Drawing No. 4,

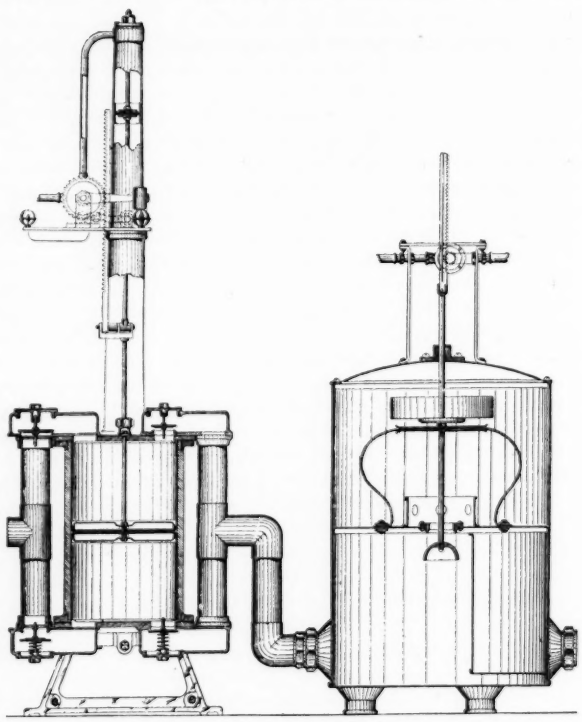


FIG. 1.—HYDRAULIC PRESSURE INCREASER.

regulating the quantity of gas to the exact amount required. These were replaced by gas-engines as shown in Drawing No. 6, because the pressure of the water was sometimes too much reduced by the turning on of a hose for washing down the roadway. The same kind of apparatus fixed at Portsmouth Dockyard was also affected by the filling of boat-tanks and the washing down of the roadways. The same thing happens sometimes for a few moments by the filling of the engine-tanks at railway stations; but the main difficulty which could not be overcome, was that the water companies, without notice, were in the habit occasionally of shutting off the water altogether. Then the station was put nearly in darkness, the burners having to burn on a pressure of not more than 1¼ inches of water. The cost of the water in the case of the Bristol Joint Station and other stations was charged at the high rate of 1s. per 1000 gallons; and this very seriously affected the cost of lighting. But as soon as gas-engines were adopted, the cost of raising the pressure up to 12 or 14 inches was immediately reduced to rather less than ½d. per 1000 cubic feet. It is found that a very small gas-engine of 1-horse power is able to keep from 100 to 120 300-candle power burners going continuously.

There were two water-engines used in the lighting of the

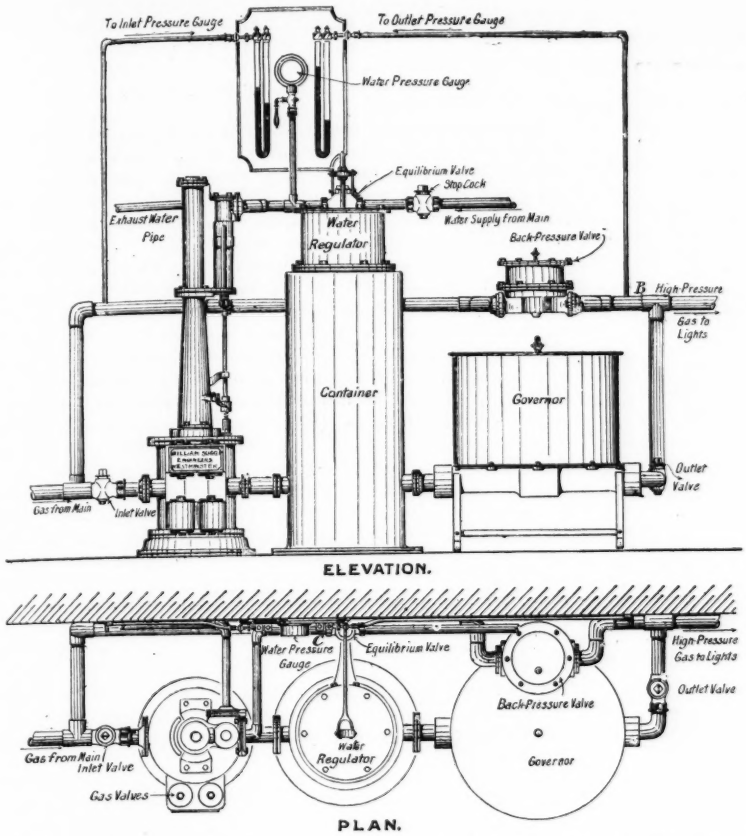


FIG. 2.—PRESSURE INCREASER AND GOVERNOR, WORKED BY WATER PRESSURE (FROM 20 TO 30 LBS.), CAPABLE OF SUPPLYING SIXTY 10-FEET PER HOUR SUGG'S HIGH-PRESSURE INCANDESCENT GAS-BURNERS.

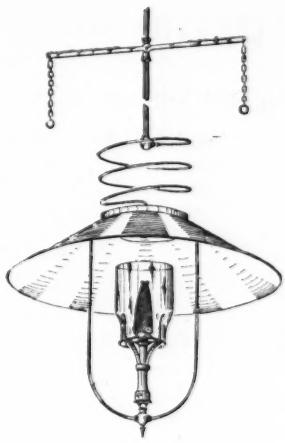


FIG. 3.

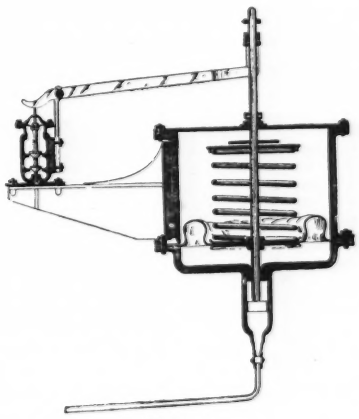


FIG. 5.

Bristol Station—one for one side of the line, and the other for the other side. These are now replaced by two gas-engines of about 1-horse power each. The mains are connected so that in case of any repairing or cleaning having to be done to the one engine, the other one is capable of lighting the whole station. Therefore, by means of either the steam or the gas engine pressure increaser, there is no danger of the system failing, as there would be with the water-motors when the water companies suddenly shut off supply. Of course, the burners which are used for the high-pressure lighting will also work on the low pressure; so that at midnight, for example, in places where they do not want so good a light, or on railway platforms when there is no train in, the pressure-increaser can be stopped, and the lights will burn on low pressure, giving about one-third of the light that they were giving on high pressure.

The pressure of the gas used on the Tower Bridge and Southwark Bridge is 10 inches, giving 10 feet of 14-candle gas per burner. At Blackfriars Bridge, which is supplied by the Gaslight and Coke Company, the gas is 16-candle power under the same pressure, with the same consumption of 10 cubic feet an hour for each burner. But by raising the pressure to 14 inches, which scarcely affects the cost of working the gas or steam engine, the illuminating power of each burner may be increased to 400 candles instead of 300 candles with an extra consumption of $2\frac{1}{2}$ to 3 cubic feet per hour per burner (according to the quality of the gas); and this quantity adds about 100 candles to the volume of light—thus making an addition in illuminating power of 40 candles to the foot, produced by this small extra quantity. In some cases where pipes are old and may not stand the pressure of 10 or 14 inches, the illuminating power may be produced by putting the air under pressure instead of the gas, and leaving the gas to enter at the foot of the burner at the normal pressure supplied by the gas companies.

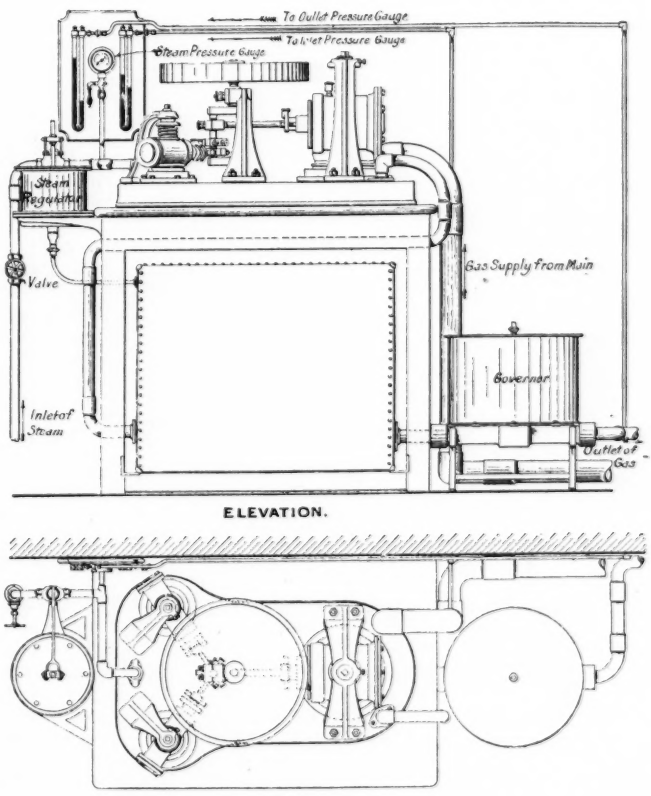


FIG. 4.—SUGG'S PRESSURE-INCREASING ENGINE WORKED BY STEAM, FROM 20 TO 30 LBS. PRESSURE, CAPABLE OF SUPPLYING THREE HUNDRED 10-FEET PER HOUR HIGH-PRESSURE INCANDESCENT GAS-BURNERS.

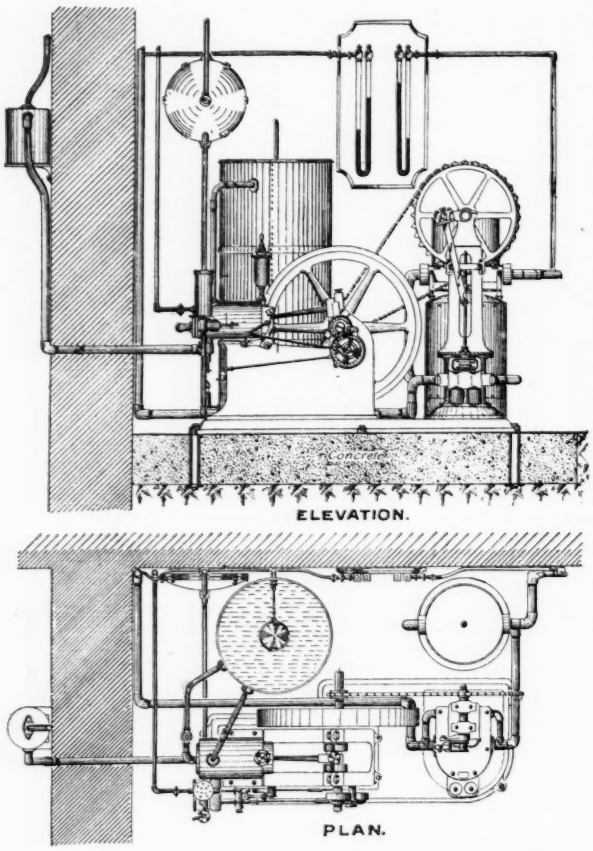


FIG. 6.—COMBINED GAS-ENGINE AND PRESSURE INCREASER.

For this purpose, the author has devised a new burner, as shown in Drawing No. 7. It will be perceived that the gas comes into the burner by a central jet, taking in a certain quantity of air with it in the usual way with bunsen burners. Around this annulus, a number of fine holes are pierced, exactly the same as those in the old argand burner, and therefore the air, under a pressure of from 10 to 14 inches (or even more if required) is delivered into the supply-tube by regularly-spaced jets, and goes up round the column of gas and air brought in by the jet till it gets to the top of the burner. There the column of gas strikes against the underside of the top of the burner, and, spreading itself out, mixes with the air and comes out from the top of the burner perfectly mixed, producing the same illuminating power as when the gas is under pressure. With richer gases, it produces a much better result, because a larger quantity of air, and consequently more oxygen, can be mixed with the gas; and this is sufficient to produce as perfect a combustion as it does with the lower qualities of gas, with a proportionate gain of illuminating power.

FIG. 7.

With such burners as these, we may look forward to making a great improvement in the illuminating power of high-pressure burners supplied with rich coal gases. Under ordinary circumstances, it is difficult to get enough oxygen induced by the velocity of the jet to properly develop the illuminating power of these gases. But with this burner, an additional quantity of atmospheric air at any suitable pressure, according to the quality of the gas, can be supplied so as to produce a perfect combustion of these rich gases, and thus considerably extend the means of employing high-pressure gas, especially for harbour lights, &c.

UNPRODUCTIVE CAPITAL AND ITS RELATION TO RENEWALS.

By ARTHUR VALON, of London.

In every trading concern having what may be called an engineering basis, the question of the replacement of out-of-date plant with apparatus of modern construction, and the extinction of the capital thus rendered unproductive, has of recent years forced itself on the attention of those responsible for the management by the ever-increasing competition of foreign manufacturers, whose works are fitted with the latest labour-saving devices and whose capital is represented by its full value in the works. Many of our engineering industries at the present time have the greatest difficulty in making headway against competition from abroad, because proper provision for inevitable renewals has not been made in the past, and capital has been allowed to remain on the books after the works on which it has been expended either have been, or should have been, disused or replaced.

In our own industry, owing to its protected position and the absence of any really serious competition, this question has not as yet reached the acute stage, although signs are not wanting that the possibility of difficulty in the future is beginning to arouse attention. No one can look through the Board of Trade returns without perceiving the wide differences in the relative capital charges on various undertakings. Some of these differences, of course, arise from the varying circumstances in which an undertaking may be placed; but as a general rule, experience shows that the heavier capital charges are due in a large measure to the accumulation of dead capital—capital which is not, and sometimes never has been, represented in works.

The difficulties attendant on an over-capitalized concern are many; but they are all usually summed up in a high price for gas—the existing consumer having to pay for all the faults of omission and commission of a past generation of directors. The present directors are, in general, only too well aware of the discomfort of their position; for they often cannot reduce the price without affecting the dividend, and are disinclined to face necessary capital expenditure for the same reason. There, at present, the difficulty ends. By keeping up the price of gas, the consumer is made to pay interest on capital which was used for the benefit of a past generation; and the dividend is thus preserved to the satisfaction of the shareholders. But the position is not a desirable one, and seems to show that something in the financial arrangements of a gas company might be improved.

It will probably be generally agreed that where the supply of an article is in the nature of a monopoly under State control, the price at which the article is sold should be governed by the cost of production, in addition to a fair return on the capital employed. If this is so, then the necessary capital involved becomes a matter of the first importance; and the question is immediately raised as to what relation the capital should bear to the works which represent it. The answer seems obvious—that, properly speaking, the capital upon which interest and dividend have to be paid should be that amount which has to be expended upon objects from which benefit is being received. Where in any undertaking this is less than the existing capital, then the difference is dead or unproductive capital; and where this dead capital exists, it ought to be written off and prevented from ever accumulating again.

Capital which has ceased to be represented by existing value accumulates in a variety of ways; but a careful examination will reveal the fact that the existence of all unproductive capital may be traced to either an insufficient allowance for renewals, or to a too narrow interpretation of the items supposed to be covered by the term. Perhaps the following examples will show more clearly what is here meant.

When it becomes necessary to replace part of the plant with plant of a larger capacity, a certain proportion of the cost is charged to capital, and a certain proportion—supposed to be based on the value of the discarded plant—to revenue. But the exact proportions are within the discretion of the company; and if an amount less than the original cost is charged to revenue, the balance is so much dead capital. In the second case, dead capital may accumulate in such ways as not writing off the cost of an Act of Parliament after it has been practically replaced by another, or where undertakings have been amalgamated, by allowing

goodwill capital to remain permanently on the books. Of course, renewals are properly chargeable to revenue. But in practice it is within everybody's knowledge that an insufficient allowance is often made; and where the objects on which the original capital was spent are not in themselves renewable, no allowance at all is made, though it seems plain enough that the principle is the same in both cases, and requires that capital expenditure should be replaced from revenue when the objects upon which it has been spent have ceased to be of equivalent value.

If this is the true principle, and it is quite certain that if properly carried out there would be no unproductive capital, then it is also clear that the allowance for renewal should be made during the period of use of the objects on which capital has been spent, and proportionately to the depreciation in value. Perhaps this may be more clearly shown as follows: A certain amount of capital is spent on providing the means of supplying gas. After some period, more or less protracted, the means provided become either obsolete or of no value. Then an amount equivalent to the original capital expended ought to have been provided out of revenue during the period of use. This, it will at once be observed amounts simply to recoupment of capital, and is the item which it is suggested ought to be substituted for renewals. [It is to be noted that this recoupment of capital has nothing to do with the repayment of loans by local authorities. In their case, it is not in substitution for, but in addition to, renewals, and is based on grounds of public policy.]

The capital charges on revenue in existing undertakings are: Interest, renewals, and repairs. I have endeavoured to show that, as interpreted, this statement does not cover the whole fair charge on revenue to which capital is entitled, but that the item of renewals should be deleted, and recoupment of capital substituted—claiming that if this were consistently done, unproductive capital would disappear. If this contention is correct, then the question to be settled is the proper method of providing for what is here designated "recoupment of capital." First, let me briefly recapitulate the conditions to be fulfilled:

1.—From the nature of the objects (save land) on which all capital is expended, their value begins to depreciate from the moment of their formation; and therefore the cost of their replacement should commence to be set aside as soon as the expenditure has been made.

2.—The consumers who benefit by any capital expenditure should furnish the recoupment thereof.

3.—The consumers who benefit by any capital expenditure, being those who are supplied during the valuable existence of the objects on which it has been spent, the recoupment should be equitably spread over the term of that existence.

It is the usual custom to charge renewals to revenue as and when the same may occur; and if this is carefully and conscientiously carried out—charging to revenue the actual original cost of the works replaced—this system will undoubtedly provide adequately for the renewals of such works as are necessarily replaced. But, as indicated before, there are many objections to it. It does not provide for replacing capital which has been expended on objects which are not properly renewable or which cease to be necessary and are not renewed. The cost of renewal is not charged to revenue until the object has ceased to exist; and therefore the burden of renewal falls on those who receive no benefit from the original expenditure. The charges for renewal vary very much in different years, and cause undesirable fluctuations in the profits.

It is certainly possible for a company working with a maximum dividend to equalize the dividend to some extent by means of the reserve fund. But where the sliding-scale is in operation, the reserve fund has been made up out of divisible profits, and ought not in fairness to be used indirectly to meet renewal charges. Indeed, in many instances the temptations offered by the action of the sliding-scale have been much too great to be resisted, and the insurance and reserve funds have no existence except in the Act of Parliament.

There is, however, another method of dealing with renewals which is not open to these objections, and which can be made to fulfil the conditions that have already been stated. Proper provision for the recoupment of capital can be made by setting aside a sufficient sum each year, which, if allowed to accumulate at compound interest, will replace the capital expended in a given number of years.

The amount to be annually paid into this fund would be a certain percentage of the capital expended in addition to the cost of renewed work. The exact percentage would require very careful consideration; but it should be possible, by equating the relative values and lives of the different parts of a works, to arrive at a period for the total recoupment which might be applied to the whole capital—save capital expended on goodwill or similar objects which it might be desirable to treat separately and assign a different term. All renewals occurring would be debited to this fund instead of to revenue; and the amount of capital expended on objects not renewed or renewable should, when the fund matured, be carried to capital account, and the original amount written off. It would, of course, be necessary that the annual payment into the renewal fund should be compulsory; and as renewals are a part of the expenditure on revenue account, the fund should be a first charge on the undertaking—that is, before either interest or dividend.

The establishment of a fund on the lines indicated would necessitate the division of renewals from repairs; and the question presents itself, Where is the line to be drawn between the two? It has often been argued that there is no real difference between repairs and renewals, but that it is merely an arbitrary division between repairs of works involving the replacement of an entire piece of apparatus which is termed renewal, and repairs of a less extensive nature involving the renewal of parts of a particular apparatus or building which is termed repairs. Nevertheless, although the division may be to some extent arbitrary, it is not very difficult for the purpose under discussion to make a workable one, because it is what perhaps may be termed complementary to the period of recoupment for the renewal fund. For instance, a gasholder during its period of existence has minor repairs done to it at intervals. A time, however, may arrive when the whole requires resheeting. Is this a repair or a renewal?

If the distinction is made that only the replacement of a whole apparatus or building is a renewal, it must be classed as a repair; but, as a matter of fact, it is of no moment so long as the distinction is fixed when the term of the fund is settled. If the resheeting is to be taken as repair, it means that the period of repayment of the fund must be proportionately longer than if it is treated as renewals. The whole matter can be adjusted if the life of the works is fixed—not the length of time for which the building and plant will exist if left alone, but the approximate time which will elapse before the buildings and apparatus must be replaced, whether because they are worn out, or because rendered obsolete by improvements, or for any other reason. Although this problem seems difficult, the difficulties are not insuperable. With the experience available, it ought certainly to be possible to arrive at a satisfactory solution, the more so as it would be an advantage rather than otherwise for the period to be taken rather shorter than is absolutely necessary; while if the fund is found not to accumulate so rapidly as required, the rate must be increased.

The lives of the different buildings and plant which go to make up the works having been arrived at, it would be possible either to treat the capital expended on different objects separately, or, as already indicated, equate the proportional amounts required for the various parts of the apparatus and their several lives, and thus arrive at a period which could be applied to all capital raised. If this method is workable—and there seems no good reason why it should not be—it is possible to provide properly for renewals and keep the undertaking absolutely free from unproductive capital; while, by applying the same principles to the existing capital, the burden of the past accumulation may be gradually removed.

But whether the proposal set forth in this paper is the best solution to the problem or not, there can be no question that some remedy must be found if the industry is to occupy a thoroughly good financial position in the future.

Up to the present time, owing to the enormous field that has been open for development, it has been possible in most cases to reduce the unproductive capital to a comparatively small proportion of the whole by the natural extension of the undertaking. But this margin for development is being rapidly filled up, and, consequently, the evils of dead capital will tend to increase, while the effect of any

competition will likewise be more severe. Under these circumstances, it is surely desirable that these evils should be disposed of while there is yet time. There is a contingency which may arise at any moment, and will certainly arise at some future time—the appearance of a serious competitor, It may be by the discovery of more economical methods of generating or distributing electricity, or by the discovery of an entirely new means of lighting and heating. But who, viewing the general progress, can doubt that at some future date a rival will appear? Let us therefore prepare, so that when that time comes, as come it must, the industry may be in a position to fight on its merits and not have to meet a young and vigorous antagonist when overweighted with a millstone of dead capital. The position of the gas industry at present is sound and free from serious competition. But what of the future?

Discussion.

The PRESIDENT said this was a very important paper, and he hoped there would be a full discussion upon it.

Mr. R. O. PATERSON (Cheltenham) said he hoped he might be permitted to compliment the Institution on the excellence of the programme of its first meeting. It was very pleasing to see the younger members coming forward in the capacity of instructors. This paper was one of a most interesting character, thoughtfully worked out, and suggestive in all its points. He had some interest in this matter—more particularly because he thought it was a paper which would be likely to call forth vigorous discussion from the general body of members. The title spoke for itself. The matter which occurred to him on reading the paper was one which went to the root of the question. The author spoke entirely of repairs and renewals, and attributed the accumulation of unproductive capital to the neglect of renewals; but if they were not in a position to do more than renew the plant, unproductive capital must of necessity accumulate. He noticed in the schedule of accounts presented for adoption in the Gas-Works Clauses Amendment Act, 1871, item No. 5, "Manufacture of Gas," read thus: "Repairs and maintenance of works and plant, including the renewal of retorts, machines, apparatus, tools, &c." There was no mention of renewals, except in connection with retorts. In No. 7 of that schedule, "Distribution of Gas," the words with reference to mains and services were "Repairs, maintenance, and renewal of mains and service-pipes." In No. 8 of the same section, as to meters, it said: "Repairing, renewing, and refixing." To him, it was hardly conceivable that a gas company working under a regulated monopoly would be allowed by Parliament to set aside an amount of cash year by year in the form of a recoupment account, such as Mr. Valon suggested, for the purpose of redeeming the capital. Mr. Valon called it recoupment; but recoupment meant repaying—that was to say, they were going to pay back the capital in some form or other. If Parliament permitted this to be done, it was all right; but the position was this—that Parliament gave power to raise a certain amount of money for the purpose of establishing a gas undertaking, and granted a regulated monopoly on certain conditions. They could distribute a certain dividend if they carried out the conditions Parliament laid down. But Parliament did not give, and never had given, them power to pay a dividend on the invested capital, and accumulate a fund for the purpose of repaying the capital again. It might be contended that Parliament had not said they might accumulate profits for the purpose of redeeming capital; but clearly it had in its mind that any company establishing a gas undertaking had power to maintain the undertaking, and there was the great distinction which Parliament must have had in view when establishing this No. 5 schedule in the accounts—"Repair and maintenance of works." There was no mention of renewals, but "repair and maintenance of works." This meant if they took down a gasholder which was a little obsolete, according to Mr. Valon's position, the capital expended on the holder was wiped out of existence, but the money remained on the books. Parliament did not say they should renew the holder; but it did say they should maintain the works. If the holder was taken down and was not going to be re-erected, and it cost (say) £5000, they were expected, and given power, to maintain the capital value of the works in some way. It did not say they should restore the holder. They might put it down in the retort-house, or in some other way; but they must put into the undertaking the value of the holder, and it must be done in the revenue account in the form of maintenance. This was how the matter appeared to him. If they had a special fund in the form of a recoupment fund, a very awkward question arose. They had not spent the money, but had taken it out of revenue, and set it aside. It might be in the case of a large undertaking a considerable amount; but it had gone out of the revenue account before the balance was struck, and they were actually paying income-tax on the amount which they had put aside. Clearly, this was a mistake. They should only pay income-tax on the balance of the revenue account, having all the expenses included in it for the year. On this ground, he thought it would be a mistake to take from the revenue account any amount of money to form a separate cash account, and leave a larger balance to revenue account chargeable with income-tax. He would like to emphasize the point of repairs and maintenance. This included renewals of retorts. They could not do anything more important in maintaining the manufacture of gas than in renewing retorts; but they could do something else with a holder which had become obsolete because of its size or other disabilities. There Parliament meant them to maintain the works at their original capital value, and included in that was renewal and repairing. In No. 7, "Distribution," it was "Repairs, maintenance, and renewal." They must renew the mains for distributing the gas by whatever sized mains were requisite; but they had also to maintain. If it was necessary to enlarge a main, they could do so if they were maintaining the value of it according to his contention, and be perfectly justified in doing it. A certain depreciation went on which they could not see; but they knew it existed. As to the question of putting a larger main down instead of a smaller one, it was not maintenance of the main, but maintenance of the value of the main. Take No. 8, "Repair, renewal, and refixing of meters." They were not instructed to maintain these; but they must do so. A repaired meter was a maintained meter, because it was a working article suitable for the purposes for which it was bought. All these matters would come under the head of depreciation; and it was this they were seeking to cover. They were not allowed by the schedule to the Gas-Works Clauses Amendment Act to have a depreciation fund, except for works on leasehold lands; but Mr. Valon's recoupment account was simply another name for depreciation. A case came under his notice where a gasholder was actually taken down because of its obsolete character; and in that instance it cost a matter of some thousands of pounds. The holder was broken up; and there was no intention at the time to replace it. What was to be done? The value of the gasholder—say, £4000 or £5000—had actually gone out of existence; but it remained in the books as a capital charge, and dividends had to be paid on this amount of capital. The contention there was exactly that which he had been trying to put before them—that the whole matter was covered by the words "repairs and maintenance." It was contended in that case that they should replace the value of the gasholder by some other works; but a difficulty came in which was not contemplated at the time. In the concern a firm of chartered accountants audited the books; and they drew them up altogether, and said: "No, you have no right to do this. You must put this gasholder down as renewal; and you must put another down in place of it, or part of another." The matter was gone into; and the opinion he put forward was advocated with the auditors, who came to the deliberate opinion that the contention he had been holding was a right one, and it could not be answered. But what they said was: "Who is to determine what is the expense required in any one year to repair and maintain the works?" He replied that this matter was easily settled. The engineer was the only person who could be responsible for the possible amount of expenditure required so as to maintain the undertaking at its full structural earning capacity.

Mr. J. FERGUSON BELL (Derby) heartily congratulated the author on his paper on a very important subject. He remarked that one could not help seeing, on glancing through the various statistics, and looking at the capital of different gas undertakings, that some of them must have a certain amount of dead capital, because the capital expenditure varied so very considerably. Looking also at the returns for repairs, maintenance, and renewals, they varied to a very large extent—showing that some were spending a lot of money on repairs, maintenance, and

renewals; while others were very prudent, to say the least. At the works he was at for some years, the first thing they did was to put 1 per cent. of the expended capital on one side to form a renewal fund. Depreciation was taking place from year to year. It mattered not really whether it was put right this year or next, it had to be put right some time; and he thought that ear-marking a certain amount each year to form a renewal fund was an aid to sound finance. One of the features of this year's parliamentary session had been to give gas companies permission to put on one side a sum to form a renewal fund. The point that Mr. Paterson raised was a very important one—that of paying income-tax on the sum so ear-marked. He had had this question at Stafford. For some years, the Commissioners had allowed them to deduct the sum of 1 per cent., and did not charge income-tax upon it; but they got a new Surveyor, and he would not allow it. They appealed to the local Income-Tax Commissioners; and they said they could not allow it, but would allow the amount that year actually expended on renewals. They let it go that year; but the next year they went before a Special Commissioner, and submitted a tabulated statement showing the amount they had actually expended over ten or twelve years for renewals, and the sum put on one side. The Special Commissioner decided that it was a reasonable deduction to be made, and allowed it; and ever since then they had been allowed the amount, and had not paid income-tax upon it. He thought if gas companies, and corporations also, would put an amount on one side annually in this way, when renewals took place they would have the money for them. Suppose they had a gasholder to resheet or repair, or a bench of retorts to rebuild, it was a very large expenditure to come on one year, and it was often deferred for several years because they could not get the money. If they had a sum put aside annually, it would not burden any single year unduly. One year a company had to spend 1½d. or 2d. on repairs, and the next year 4½d.; and this made a great variation in the profits, which had to be explained, not only to the shareholders, but also to the corporations.

Mr. Henry Townsend (Wakefield) did not think Parliament had sanctioned a renewal fund this last session. One of the undertakings in Parliament last session, however, applied for powers to create a renewal fund; and they were not granted. With regard to the paper under discussion, it struck him that the methods the author advocated were rather complicated; and as it would be impossible to carry them into practice without the sanction of Parliament, and Parliament being unable to swallow the renewal fund, it would be very difficult to get them to agree to these suggestions. The matter divided itself into two parts. A great many works represented in the room were corporation gas undertakings. They were dealing with public money; and Parliament wisely decided that the public money should be rendered safe by means of a sinking fund. The other classes of undertaking were private enterprises, or companies. To them, Parliament had granted certain privileges—given each a monopoly, and had left them the burden and the risk of making the capital remunerative in the ordinary way. Mr. Valon's concluding remark was "But what of the future?" That would be provided for in this way: If the undertaking could not be made to pay—if the competitors which Mr. Valon foresaw arose, and the remunerativeness of the concern did diminish—dividends would go down, and the unproductive capital would very soon be written off. Another point to be borne in mind was that, in creating any new fund such as was suggested, they were burdening existing consumers with an additional charge, increasing the present price of gas, and making competition more difficult. It was a matter demanding serious consideration before applying to Parliament to add a burden which might be very awkward to deal with in face of the competition which was certain to come about through Mond gas and electricity power schemes. His own impression was that they would be far better without such legislation as Mr. Valon suggested.

Mr. W. B. Randall (Waltham) congratulated Mr. Valon very sincerely on his paper. He would suggest to him the advisability or otherwise of considering the question of opening a suspense account to meet the case of resheeting a gasholder, or parliamentary charges which were incurred for a Provisional Order or a new Act. They knew from experience that often parliamentary charges ran up very high through undue opposition; but if the matter were looked fairly in the face, such charges should not be placed to capital account, but to a suspense account—writing it off at so much a year, as the finances would allow. When an account was placed on the balance-sheet as a suspense account, directors and shareholders all looked upon it as a matter which had to be wiped out at the earliest possible date, without seriously interfering with the dividend; and being in this form, it did not cripple the company in the future, as it often did if put on one side of the capital in the hope that some other plant might be provided out of revenue—which was frequently forgotten in the idea of conciliating shareholders and paying dividends up to the full, without properly considering the future. With reference to the possible effect on the price of gas, Parliament allowed municipal authorities to wipe out their debts; but in the case of private companies, it was left to the caprice of the directors whether the capital account should be swollen or an inflated dividend paid at the risk of the future. Another point was with reference to stoves and automatic fittings. They were dealt with in various ways, frequently by putting them to capital account; but he would suggest that they should not be treated in this manner. Stoves and automatic fittings should be placed to a floating account, and a certain amount of depreciation should be written off each year, and in addition to that the depreciation as well. Then, instead of accumulating an incubus which must affect the status of many companies in the future, they would have those matters under their own control, and not be making burdens which the future would have to bear.

Mr. David Vass (Airdrie) said he should like to support Mr. Valon's contention with regard to the depreciation of capital. He was in the fortunate position of not being tied by any Act of Parliament with regard to the Company he now served, or with regard to the one he was with previously. They always made it a point to write off sufficient depreciation—as much as they considered the works would depreciate during the twelve months. If the undertaking was value for £50,000 to-day, it certainly was not value for £50,000 a year hence, even supposing it underwent ordinary renewals. Therefore they were justified, as commercial men, in writing off an amount for depreciation. No engineering business would be conducted on any other lines; and he thought it was their duty, as engineers, to press this matter on Parliament. Why should they allow a corporation not only to write off renewals, but to write off a sum sufficient to recoup the whole capital, whereas a gas company working under the Acts were not allowed to keep their plant up even to the capital invested in it? Parliamentary charges in commercial concerns other than gas companies were usually written off within a few years, and they should be met much in the same way in gas undertakings. In collieries, where they were not only dealing with machinery, but also working up the material on which their capital was expended, they always depreciated to a very large extent; but, of course, gas-works were more like an engineering undertaking. On this basis, they were entitled to write off at least 1½ per cent. on the whole capital of the company. It was a difficult point to find out what should be the annual sum. He went carefully into the paper by Mr. Lass; and, as near as possible, he found it would take about 2 per cent. on the capital value of his Company to reproduce the works. In addition, they wrote off a heavier sum on the meters, and on gas-stoves as much as 10 per cent. In this way, it might be said the gas-stoves gave no revenue; but if the undertaking came under the hammer within so many years, the book value would be the same as they would receive for it.

Mr. C. A. Craven (Dewsbury) said he had listened with considerable pleasure to Mr. Valon's paper, and many of the author's conclusions he quite endorsed. But at the end of his communication, Mr. Valon seemed to raise a few points which he did not think were very tangible. He remembered when he came back from South America, at the time the scare was on about the commencement of the electric light, a gentleman he met in London told him his father had a large holding in gas shares, and asked him what he recommended him to do, seeing the shares had gone down. His advice to him was to buy as many as he could, and not sell one. He did not think there was anything in sight which should make them at all afraid of the future of gas-works. From all they had heard, he thought

they could well hold their own. An amusing thing occurred in their Corporation, after they began the electric lighting scheme. A very influential member said that the gas-works would gradually dwindle away, and the electric light would take its place; but he did not see that there was anything better to do than to leave Mr. Craven to gradually let it die out, and take care of it as well as he could. He laughed at it at the time, and told him he never had any uneasy feeling on that point. With regard to the recuperation of capital, they were put in a very unfortunate position in the arbitration as to the value of the works. The charge was, roughly speaking, about 2s. 6d. per 1000 cubic feet; but now they had got it down to 10d. He did not think he could defend altogether what the Corporation did in some respects, because they might supply gas at cheaper rates; but they had so many impecunious people, and they had to help them. They erred on the right side in maintaining the good condition of the works. Several of the members had been at their works; and they would bear him out in saying that they were kept up to their proper value. Some time ago, they spent £10,000 in pulling down a bench of retorts which had pretty well done their work, and in installing inclines; but they had the money ready for it. They did not find any difficulty with the auditors, because they were reasonable people; and if they wanted to improve the works, they had no objection, when the money was ready for it. They had not added to their capital—in fact, they had no new capital account, and they were increasing the mains in various parts of the works. He thought a reasonable amount ought to be allowed for reducing the capital of works. They had lowered it considerably, and should continue to do so.

Mr. J. Hepworth (Edinburgh) said he had listened with much pleasure to the paper. Mr. Valon began by describing very properly the serious effect of heavy capital charges; and most of them, he feared, would not have to travel far for an illustration of the very grave matter it had become in the case of one Company. Mr. Valon, impressed with the serious nature of these very heavy charges, suggested a method for dealing with them under the word "recoupment;" but it struck him, as it must have done Mr. Paterson, that Parliament—which had refused over and over again to allow anything to gas companies in the shape of depreciation—would not be likely to permit anything in the way of recouping, if by that Mr. Valon meant setting aside a certain fund to replace dead capital. But he was not quite sure that this was what Mr. Valon meant. He thought under the present condition of things they must provide for dead capital, and could only do this by apportioning it to repair and maintenance. If, for instance, he had a gasholder which cost thousands of pounds, and after thirty or forty years it had become useless, and he wanted to build a retort-house where the holder stood, the only course, he should say, was to provide for the value of the disused holder out of the profits for the time being. He did not know whether Mr. Valon advocated a separate fund for that. Probably he did; and he would venture to say that the author might, in his reply, suggest how he would set aside this part for replacing capital alongside of the amount spent on repairs and maintenance, and both of which, he took it, were to be provided out of revenue alone. It was not very difficult for an engineer to anticipate what was coming; and if the holder which he had used as an illustration was going out of existence, the engineer would wisely set aside during two or three years the amount requisite for providing for this useless plant. He had listened to Mr. Bell's remarks with great interest; but it would surely be impossible for any gas company to do what he advocated. Mr. Bell was no doubt dealing with the case of a corporation of which he had had considerable experience. He did not think it mattered much whether he put by 1 per cent. or 5 per cent. (as possibly some did) for renewals. He thought it was a very wise thing to do; but no company could do it. There did not seem to be any great necessity for a corporation doing it, when they were already paying off their capital, and which must be repaid within a period of thirty or forty years. The important question was the proper charge for repair and maintenance, which was a point he did not think every gas engineer had properly considered; and this paper, if it had done nothing else, had called attention to the proper apportionment of charges under that section.

Mr. J. P. Leather (Burnley) said to him, as an engineer for a corporation, and one who had not had experience with companies, the subject of the paper had not quite the same practical bearing as it would have to some; but nevertheless it always seemed to him that gas companies did work under somewhat peculiar conditions, or on rather uncommercial lines, by having practically the whole of their capital as share capital which could not be written off. However confident they might feel about the future, it was wise to anticipate something of what Mr. Valon had named, and if they got to the point that gas-works no longer increased, the main structural buildings, and so on, about the works would be depreciated, and they would not have the opportunity of renewing them in the same way as if the works were increasing rapidly. The great point of how the difficulty was to be met, depended on the legal position of a statutory gas company; and it turned a good deal on the words Mr. Hepworth had used, "out of the profits." Mr. Valon suggested that the consumer should pay all this; but that was hardly what was done in an ordinary commercial undertaking. He was a director of a company—not a gas company—and they were content, if they made 12 or 13 per cent. profit, to pay only 10 per cent. and put something by. They regularly set aside a sum for depreciation, and had done so ever since the company was formed, when they were paying smaller dividends. It did not come out of anybody else's pocket. They made all the profit they could, and depreciation came out of the profits. This was where the difficulty came in. The second question was whether Parliament would permit them to do it. Probably it would not allow them to go on paying a maximum dividend and also putting aside this renewal fund, which would keep up the price of gas. In an ordinary undertaking, the price of the article was not fixed. It had to be sold for what could be got for it, rather than at what people chose to charge; and in that case, if they put aside something for depreciation, it was done out of profits. This was really the difficult point. Mr. Valon suggested that the consumer should pay it all; but he doubted if Parliament would permit it.

Mr. James Whinster (Armagh) said this subject was of considerable interest to him. He had had in his experience to fight three Income-Tax Surveyors personally over this very business. With every new man that was appointed, the whole question had to be threshed out again. They paid the ordinary repairs and maintenance, according to the scheduled form of accounts, out of revenue; and then their practice had been to write off 2 per cent. depreciation on the present value of the works and plant, 10 per cent. for meters, and 10 per cent. for stoves. The fight he had with the Surveyors was always about this. They said: "We cannot allow your ordinary repairs and maintenance, and then allow you this depreciation; you have no right to depreciation on the buildings." The last one stuck to this hard and fast for a long time. He was, however, told that if he persisted, they should give notice of appeal; that if they were not allowed 2 per cent. on everything, they should claim 10 per cent. on the machinery; and that if he knew anything about gas-works, he would know there was more machinery than buildings in them. He appreciated the force of this argument, and yielded; but with the next man that came round, the fight would begin all over again. With reference to the enlargement of plant—for instance, taking up a 3 or 4 inch main and putting down a bigger one—his plan had always been to charge to repair and maintenance as much as the original main would cost to lay at the present day, and to charge to capital account the difference between the present cost of (say) a 3 and 5 inch main. One thing had cropped up recently which he was not quite clear about yet; and he should be glad to have some light upon it. Last year, they spent £1000 on a retort-house, in clearing out some old benches, putting up new benches, ironwork, and everything complete. They did not want to charge any of this to capital, though they were increasing the number of retorts, so they paid as much as they could (about £300) out of ordinary revenue, and the other £700 was taken from the reserve fund, with the intention of replacing it by and by. But his difficulty was this: The income-tax people would be claiming income-tax on the £700 when they came to put it back to reserve, because it must pass through the profit and loss account. How was this to be dealt with?

Mr. W. Hardie (Tynemouth) said he listened with great pleasure to the paper, because the subject was one of the most important. As Mr. Bell had pointed out, the differences that appeared in the capital accounts of the gas com-

panies of this country were something extraordinary; and certainly some of them were in a very bad way indeed. Still, he was inclined to think that this was not altogether due to parliamentary conditions, but to the bad management of the companies who had these extraordinary capital accounts. It seemed to him that Parliament did not allow depreciation. Consequently, he took it for granted the works did not depreciate; and he thought they ought not to depreciate. As Mr. Valon had said, they had got over the difficulty in the past owing to increases from additional consumption, and so on. He was not one of those who believed that gas companies were going to cease. He thought they would be still going on for many years to come; and he hoped the competitors who had been threatening them for the last 25 years would continue to threaten them in the same way for another quarter-of-a-century. The capital of all companies should be kept as nearly as possible to the actual structural value of the works. It seemed to him unfair to the consumers at the present time if they were going to charge a large amount of money to revenue account which might fairly be charged to capital. Some companies had now their capital charges down to very extraordinarily low figures. This had been done at the expense of the past consumers; and no doubt it left the present consumers in a favourable position. But they had to consider the consumers of to-day, and the consumers of the future, and do the fair thing between them. To do this, they should charge the proper proportion of renewals and repairs to the current year, so that the value of the works in the capital account should represent the structural value of the works. He was under the impression, as Mr. Bell said, that something in the nature of a renewal fund had been granted by Parliament last session; but if he was wrong, he was not seriously concerned. Having found the necessity at all times of making provision for very big repairs or renewals, he had not experienced any considerable difficulty. He did not know that very much restriction was put upon them with regard to the amount carried forward from year to year. It was a sort of fluctuating charge, and prevented the cost of renewals coming all on one year.

Mr. W. H. Y. Webber (London) said an error had crept into the discussion in the statement that Parliament did not grant renewal funds. As a matter of fact, Parliament had done so in one or two cases this session. The last precedent was that of the North Middlesex Gas Company, who got a 1 per cent. renewal fund allowed. It did not amount to a new departure in policy at all, but was a sort of direction to the administration that they could do this. They could do it without parliamentary powers.

The President said Mr. Valon must have been much pleased by the amount of discussion his paper had received. He should have liked to have heard more on the second point—namely, that the consumers who benefited by capital expenditure should furnish the repayment thereof. As a matter of fact, the consumers of to-day were always providing actually for those of to-morrow. If they put up a gasholder to-day, they did not put up one only large enough for the present needs, but one sufficiently large to serve for some years; and in this way the consumer of to-day provided for the one of to-morrow. It seemed to him that, to some extent, this was an injustice to the consumer of to-day.

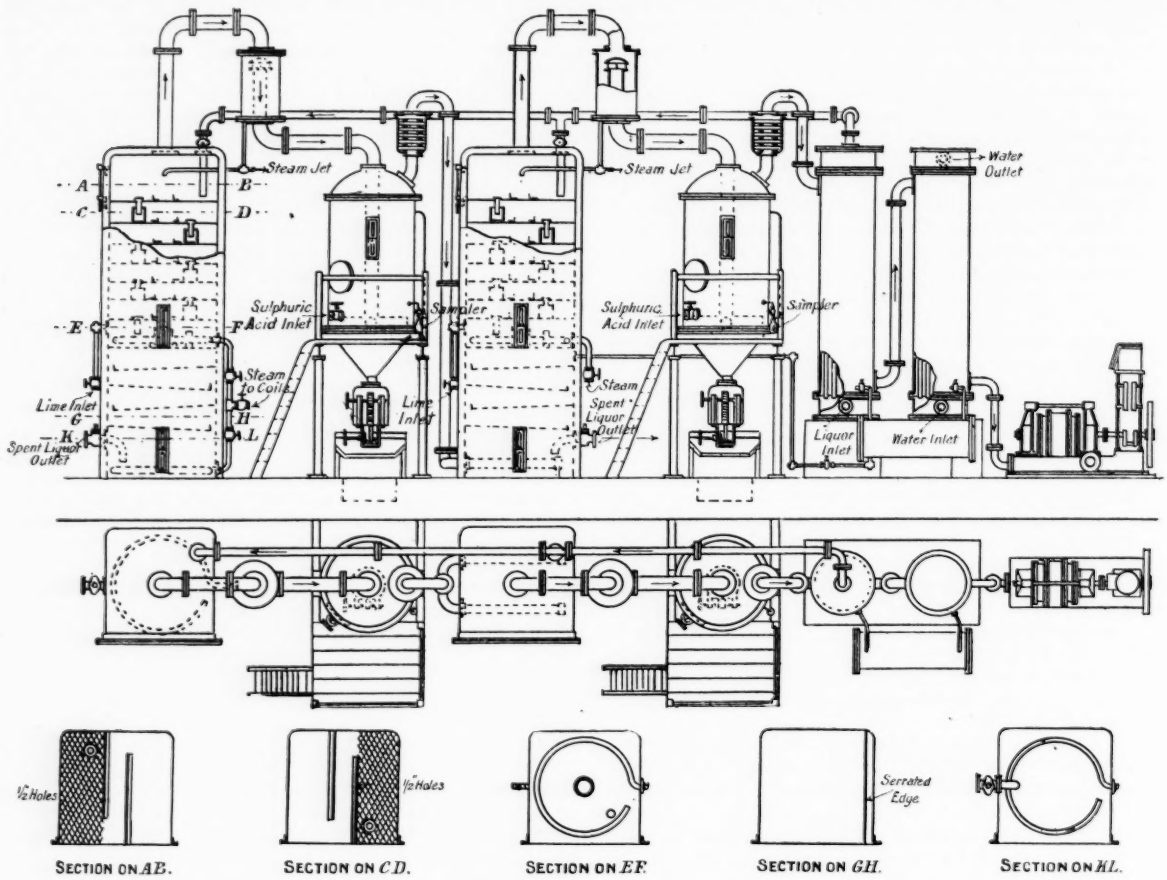
Mr. Valon, in reply, said the object with which the paper was written was to give an opportunity for discussion of this subject, because it seemed to him that it was very greatly needed; and the object had been very well attained. They had had the opinions of a large number of gentlemen—opinions which were valuable if for one reason alone, that they were speaking from a life-long acquaintance with gas-works management. The paper divided itself roughly into three parts. First, that the existing arrangements of providing for renewals were not adequate—that what was supposed to be covered by renewals did not actually cover all that should be covered by the item. The second point was the principles which should govern any method of dealing with this matter; and those he put in the paper and numbered 1, 2, 3. The third part was simply the suggestion that the whole matter could be equitably dealt with by the formation of a renewal fund. With regard to the first point—that the existing arrangements were not adequate—though he had listened very carefully, he did not hear anybody suggest that they were. The existing arrangements, if fairly carried out, did provide for the replacement of plant when it became necessary to replace it; but he had tried to show that where plant became obsolete, and was not renewed, then the capital ought to be replaced. One speaker agreed with this, though he did not agree with his way of dealing with it. He said if any plant became obsolete, it could be replaced by any other plant; if a retort-house were worn out, they might replace it by a scrubber, by a gasholder, or anything else. This amounted to the same thing that he contended for; they were simply replacing capital, and using that capital on something else. With regard to the second part of the paper—the principles which should govern provisions for renewal—surely the gas consumers were the people who benefited by the capital expenditure, not the shareholders. The shareholders obtained a certain amount of interest for the money which they provided; but this interest was provided by the consumer, and it was provided by him because he wanted gas. In addition to this, the consumer certainly had to provide for the upkeep of the concern, unless it was contended that the interest which was paid to the shareholders included the repayment of their capital. In that case, the shareholders' capital should only exist so long as the apparatus existed upon which it was spent, at the end of which time it would be wiped out, and the people lose their money. Under those circumstances, would anybody invest in a gas concern, except with a very much higher return on the capital than was obtained at present? The third part of the paper was the question of the formation of a renewal fund; and here the whole difficulty seemed to be, first, that the formation of a renewal fund on the lines indicated would not be sanctioned by Parliament, and, secondly, that the replacement of the plant should not come out of the consumers' pocket, but out of the profits. To take the last point first—what the replacement of capital ought to come out of—in the case of a statutory company they were not under ordinary commercial conditions; they were under statutory regulations, and the profits were limited to such a sum as Parliament considered was a fair return on the capital outlay. After a certain amount of interest had been paid on the total capital, the whole remaining profit went to the consumer. They could only pay a certain dividend; and after that they had to reduce the price of gas. The principle was that the dividend on the outlay was to be practically secured within certain limits, and that therefore any upkeep, any expenditure to keep the concern going, should come out of revenue—out of the consumers' pockets. As far as Parliament was concerned, if it was considered that the existing arrangements were unsatisfactory and inadequate, and if it could be shown that the formation of a renewal fund on the lines he indicated was the only way of dealing with the matter, he did not think there would be any difficulty with Parliament. Parliament had shown itself fairly well open to conviction with regard to progress in gas engineering matters. It had agreed to a reduction in illuminating power; it had agreed, in the Gaslight and Coke Company's case, to the paying off of capital, and in one or two instances to a renewal fund; but, above all, it had agreed to that apparent infringement of all the rights and privileges of capital—the workman director. In the face of this, he did not think, if it were shown that some alteration of the law were necessary, that Parliament would be behindhand. This matter seriously concerned the future; and unless it were settled, there would be more difficulty in meeting competition than there had been in the past.

SULPHATE OF AMMONIA MAKING BY A NEW PROCESS.

By J. Ballantyne, of Hamilton.

Many methods have been tried for making sulphate of ammonia in the past, and one known as the "intermittent"—still found in some small works—long held a foremost place. In course of time it was supplanted by a modification of the Coffey still, which became known as the "continuous" process; and it has been largely introduced during recent years into works where sulphate was not previously made. Now another competitor has appeared in the field, which may be termed the "continuous vacuum" process; and it will probably in the course of a few years largely supplant the present continuous method, as the system of working under vacuum has been introduced of late with great success into various commercial manufacturing concerns.

The first vacuum plant for making sulphate of ammonia



VACUUM PLANT FOR THE MANUFACTURE OF SULPHATE OF AMMONIA.

was erected at Hamilton in 1901 by Messrs. Ernest Scott and Co., of London and Glasgow. Naturally, the plant was of an experimental nature, being the first of the kind, and took some time to develop, as there were a number of details in connection with the working of it which required attention. But after a time these difficulties were all successfully overcome, and the result is that a plant has now been devised which is eminently satisfactory in every way, and which I think will soon take a foremost place in the manufacture of sulphate of ammonia.

The general arrangement is something similar to that of an ordinary continuous plant working under pressure; but there is in addition an engine and vacuum pump provided for keeping the plant under a high vacuum while it is in operation. The vacuum on the pump may be as high as 28 or 29 inches of mercury—that is, equal to lifting a column of water about 31 or 32 feet. This has enabled us to do away with all overhead tanks for liquor and acid, as these can be drawn into the still and saturator from the floor level, or very little above it.

The ammoniacal liquor on its way to the still is first heated in a superheater or economizer by the waste gases of the plant. It then passes into the still at the top, and travels backwards and forwards over the trays, which are formed of steel plates, and provided with baffles on one half of the tray, the other half being perforated with ½-inch holes through which the steam and gases rise. The liquor overflows to the next tray by an overflow-pipe dipping into a suitable seal-pot. The pipe is so arranged that the liquor on the tray is about ½-inch deep, and the steam and gases as they ascend through the holes prevent the liquor passing down them, and at the same time bubble through it in a large number of small streams, thus effectually driving off all the free ammonia.

By this arrangement of making the steam and gases pass through the holes, all the liquor is brought into close contact with them before passing to the next tray. The overflow is placed at the end of the travel, and the liquor must pass over the holes to reach it. There are no hoods, cups, or other appliances used. This process is continued over the trays until the middle of the still is reached, when the liquor passes into the liming chamber, and is mixed with milk of lime in the usual way. In this chamber, a perforated steam coil is placed, which thoroughly agitates the liquor, causing evolution of the various gases.

After leaving the liming chamber, the liquor flows over another series of trays, which, instead of being perforated, have serrated edges over which the liquor passes in its passage from one tray to the other; the gases and steam rising between the serrations and the sides of the still. In the bottom of the still is another perforated steam coil which keeps the liquor agitated, and produces sufficient heat for driving off the last traces of ammonia.

The gases after leaving the still go through a large baffle vessel or trap on the way to the saturator. The only live steam required for the still is in connection with this trap. It is not possible to get an effective seal on the pipe from the trap for returning the liquor to the still should it froth up and overflow. The priming over of the still into the saturator is of frequent occurrence with most plants. To entirely prevent it in the vacuum plant, a small steam-jet is introduced, which acts like an injector, and blows any liquor which may get into the trap back into the top of the still. The return pipe from the trap is carried into the centre of the still, and has a knee on its end looking downwards; and the steam and any liquor which may get into the trap, as they rush out at the knee into the top space of the still, have the effect of breaking-up the froth, and driving it back—thus reducing to a minimum any liquor getting over into the trap. Since a similar arrangement was fixed on our still, we have never had the slightest trace of priming. Our plant originally had no provision for priming, and it was surprising how seldom it occurred. The steam-jet is so arranged that it is easily withdrawn and examined, and the orifice cleaned if necessary, while the plant is working. I would also here point out that many little repairs can be effected on a vacuum plant while working, which could not be done with a plant under pressure.

The gases are brought down the centre of the saturator by a lead pipe, from which radiate three or four distributors

fixed to copper supports, with copper straps and bolts, so that they cannot wobble about in any way, but remain quite rigid in their positions. The saturator at Hamilton has now made about 300 tons of sulphate, and when examined recently the holes in the distributors were as perfect as when they were first made; there being not the slightest trace of wearing or fracture of any kind to be seen on the holes. This is remarkable, especially when it is compared with the condition of distributors of ordinary plant, which are generally found to have the holes enormously enlarged and torn, thus impairing their distributing powers. The perfection of the holes in the vacuum distributors is undoubtedly due to the plant being under vacuum, which allows the gases to freely escape without pressure of any kind.

The saturator is a cylindrical vessel made of copper with a semicircular top and conical bottom; the distributors being placed immediately above the conical part. To the bottom of the saturator is fixed a discharger, which opens into the saturator by an internal valve operated by a hand-wheel and pinions from without. When the discharger is full, the internal valve is shut and that on the side opened, and the sulphate is raked out on to the draining-table; the quantity withdrawn being about 1 cwt. at a time. This operation only occupies a minute or two, when the valves are reversed, and the operator is at liberty to attend to other matters, and wheel the sulphate into the store. For larger plant, the discharger can be made to discharge from the bottom into a suitable movable vessel running on rails from which it can be tipped into the store. The sulphate when withdrawn from the discharger is nearly dry, and is very soon ready for filling into bags. We find the best salting-point of the saturator to be from 56° to 57° Twaddel. A simple arrangement allows a sample of the liquor in the saturator to be withdrawn at any time for testing. The saturator requires no wood lagging or covering of any kind.

The waste gases after leaving the saturator pass through a baffle-box, and then into the superheater for heating the liquor before the latter enters the still. From the superheater the gases go through a water tubular condenser to be cooled before passing through the vacuum pump on their way to the purifiers. Burning the waste gases is not now sanctioned under the Alkali Act, unless in the production of sulphuric acid or some other way whereby the sulphur may be recovered. The vacuum pump at Hamilton is a water displacement one, and requires that the gases should be cooled before entering it; but I understand the firm now supply a dry vacuum pump, and the gases do not require to be cooled to the same extent before going through it. That is to say, if the gases are somewhat warm, the vacuum is not thereby reduced, as it would be in the case of our pump.

The whole plant being under vacuum, all the steam necessary for the still may be obtained from the exhaust of other engines in use on the works, so that the only live steam required (with the exception of the small jet referred to) is for the engine of the vacuum pump, and any other pump necessary for working the plant. But the exhaust steam from these can also be used. At Hamilton nothing but exhaust steam is employed in the still, and it is obtained from the exhausters and the engines of the tar and liquor pumps, along with that from the vacuum pump and a small Worthington pump used for circulating water through the condenser, which is of the tubular type. We take the water for this purpose from the tank of a gasholder near at hand, and put it into the tank again after it has passed through the condenser. The water is withdrawn from the bottom of the tank and returned at the top.

We find that not much more than half the exhaust steam of the works is required for the still, the temperature of which while working is from 75° to 78° C. at the steam inlet. This is a much lower temperature than that of an ordinary plant working under pressure, but, being under vacuum, the liquor boils, and the ammonia is driven off, at a considerably lower degree. The lower temperature also causes a much larger crystal to be formed. The supply of exhaust steam is regulated by valves which enable us to use whatever quantity may be needed for the plant. There is also a Tangye pump for taking away the waste liquor from the plant to an old gasholder tank so that it may be used for quenching coke, as we are not allowed by the County Council to run the waste liquor into the drains. But as this pump is one of the single-action type, its exhaust steam is not available under vacuum.

The engine of the vacuum pump requires 2 cwt. of coke per ton of sulphate made to raise the necessary steam for driving it; and the two pumps and small jet require other 2 cwt. for their steam. Thus we have a total fuel consumption of 4 cwt. of coke to each ton of sulphate made, which is exceedingly low. We have tested the quantities of coke used by the boiler during a run of the sulphate plant, and compared it with that employed when the plant was not working; and we found it to be at the rate of 4 cwt. to each ton of sulphate. The plant makes from 2 to 2½ tons of sulphate per 24 hours; and the extra fuel used in the boiler when the plant is working is from 8 to 10 cwts. of coke per 24 hours. With an ordinary plant we should have required the two pumps; so that for a consumption of 2 cwt. of coke per ton of sulphate made we get our vacuum which enables us to utilize the exhaust steam that would otherwise be passed into the atmosphere and lost. This saving in fuel is one of the particular features of the plant, and a strong recommendation for its adoption.

The vacuum on the pump and saturator in our case being from 22 to 24 inches of mercury, and that of the still from 13 to 15 inches, the wear and tear of the plant is evidently going to be very small. There is not the slightest sign of pitting to be found inside the saturator, notwithstanding a considerable amount of abuse it received during the experiments that were necessary during the earlier stages of developing the plant. With the vacuum there is a strong drawing-away tendency of both gases and liquor from the sides of the vessels, whereas under pressure the action is the opposite—the gases and liquor being pressed or forced into the interior surface of the vessels, thereby causing more rapid wearing away of the metal. The life of an ordinary lead saturator working under pressure is generally found to be from two to three years, during which time it usually requires a considerable amount of repair. But we expect the copper one to last eight or ten years without repairs; so that, although it may cost more at first, it should be cheaper in the end, and cause less trouble.

The sulphate produced by this plant is of a very high quality, both in regard to the percentage of ammonia and to colour. Some tests have shown as high as 25·70 per cent. of ammonia, and 25·20 is the lowest we have had. This is no doubt owing to the exceptionally large size of the crystals produced, which allows the salt to dry rapidly, and so contain only a very small percentage of moisture. The sulphate also remains in a very friable state when dry, and practically requires no breaking for filling into bags. Considerable time is therefore saved in this respect.

The whole of the operations of the plant are easy of manipulation, and cleanly in every way; and any man of ordinary intelligence can have no difficulty in learning to work it. The saturator being completely closed, no skimming is required; and the operator does not need to stand over a boiling vessel to skim off arsenic and other impurities. When the plant is not working, the engine and vacuum pump may be utilized for revivifying the oxide *in situ* in the purifiers. This is done by having a stopcock for the purpose at the back of the vacuum pump, by which air is drawn in, and then sent forward into the purifier. The quantity of air can be easily regulated, so that there is no risk of setting fire to the purifier grids, if wooden ones are in use. We have found this arrangement to work most satisfactorily, as it obviates a lot of handling of the oxide, and consequently is a saving of labour.

As the saturator is entirely closed, as already stated, we had to use acid commercially free from arsenic, which was expensive. This was a drawback to the plant, as the saving in fuel was more than swallowed up in the higher price we had to pay for the acid. But we have been able to devise a very simple, inexpensive, and easy method for using common tower acid. This is accomplished by passing the waste gases from the plant through the acid until all the arsenic has been precipitated as a sulphide, which is afterwards filtered out.

I do not feel at liberty to divulge the materials used in the filter or its construction; but the materials cost only a few shillings, and are easily obtained. There is not the least likelihood of a "corner" ever being formed in them. There is much more sulphuretted hydrogen in the waste gases than is necessary to precipitate all the arsenic it is possible to have in pyrites acid.

The arrangement for dealing with the acid consists of an overhead precipitating tank, to which the acid is elevated

by a steam acid-raiser in the usual manner. The gases are then passed through it until all the arsenic has been precipitated, which generally requires about three hours. From the precipitating tank, the acid gravitates to the filters at a lower level; and from these it flows into a storage tank, whence it is drawn into the saturator. From the precipitating tank, the waste gases pass on to the oxide purifiers. Samples of the sulphate made by the two kinds of acid are submitted; and it will be observed that that made with the common tower acid after treatment is equally as good as that made with the dearer acid.

The foregoing remarks apply to what is called a "single-effect" plant, and is what we have at Hamilton, although it was at first intended to erect a "double-effect" plant. We found, however, the former to be quite large enough for our purpose. Where exhaust steam may not be available, or not sufficient, and live steam has to be used, a considerable saving will be further obtained by the double effect plant; as the waste gases from the first still and saturator, as shown on the drawing, are utilized for heating the liquor in the lower part of the second still. Only one superheater, condenser, and vacuum pump are required; and as practically double the quantity of liquor can be dealt with, and therefore double the quantity of sulphate made, it must be evident that the saving in fuel per ton of sulphate will be much greater in the double-effect plant, besides a smaller floor-space being required.

The principal features in the vacuum plant may be shortly stated as follows: Labour is reduced to a minimum, the exhaust steam which was allowed to go to waste is utilized and made profitable; and consequently a large saving in fuel is effected, and a first-class sulphate, practically free from arsenic, is produced from the cheapest form of pyrites acid, which acid can be freed from its arsenic and filtered, without any reduction in its strength, at practically no cost for working expenses.

Discussion.

The PRESIDENT said he hoped there were a good many sulphate makers present, so that the paper might have a full discussion. If there were any there who had used saturators with any similar method for discharging the sulphate, he should like to have their opinion. He heard the other day of a plant for dealing with the waste gases where they were burnt in special furnaces washed with water, which was then run into a tank along with the effluent liquor from the stills. In this way, clear water was produced. He was told there was no difficulty in getting permission for this water to go into the sewers; but he should like to know something about the cyanogen in it.

Mr. J. P. LEATHER (Burnley) said this paper was certainly interesting to all who had anything to do with sulphate manufacture, though there might appear to be some points in which they could hardly see entirely with the author. He noticed that Mr. Ballantyne gave his reason for some of his results, which they were told the other day it was a dangerous thing to do. He made the assertion that the holes in the pipes in his saturator were not enlarged in the same way as they were in ordinary plants; and he said this was entirely due to their being under a vacuum, which allowed the gases to escape without any pressure. He must say he did not understand this. There was a pressure, even though there was a vacuum. That which wore a hole away by passing gases through it was the friction of the gases which had to pass through the holes whether under one pressure or under another. The saturator was of a somewhat uncommon type, being made of copper. The only ones he had ever seen of this make were under pressure. This one, being under a vacuum, was under rather different circumstances; and he should like Mr. Ballantyne to state what the strength of copper was, because, under such a vacuum as he spoke of, there might be a possibility of collapse, unless the plates were strong enough. One thing he spoke of as though it was an advantage, was the large size of the crystals of sulphate of ammonia, which to him was rather a surprise. He must say the sample sent round did not look as nice as crystals which were smaller. There was no comparison in whiteness with those he was in the habit of making—not because there was any colour about the crystals, but because of the size of them. A large crystal did not look as white as a small one. At the same time, as long as it had such a percentage of ammonia in it, there might be no difficulty in getting rid of the sulphate. This was a little surprise to him also, because he had an impression that large crystals did not contain quite so much ammonia. They had made large crystals—occasionally an inch in diameter—but they did not generally find they could sell them. The great advantage of this plant seemed to be in the economy of fuel; but this would only apply where it was convenient to put it close to the point where the exhaust steam was available. If it had to be put where there was no exhaust steam at hand, the advantage would be lost, and the cost would be increased. The next point was that of the life of an ordinary lead saturator, which the author put down as from two to three years. He could only say that last year he took out a lead saturator which was new in 1873. It certainly had not worked all the time, being out of use for three years; but this left 26 years as its life. Mr. Ballantyne spoke of a life of eight or ten years for copper; but he (Mr. Leather) hoped it would last much longer. His experience was that lead saturators, properly made, would last a long time. There had been, during the last six or eight years, a moderate amount of expenditure on repairs to the one he referred to; but for the first fifteen or sixteen years, it had very little repair. It was made in the early days of strong plate-lead saturators, and he believed was made better than they were some few years later, though good ones were now manufactured. The author referred at the end to a double-effect plant; but he did not gather whether it had been used. It seemed to him that one serious objection to it was that by putting the waste gases from the first saturator through the second still before the lime was added, the waste gases would come in contact with the limed liquor. They had found that, if they did not get rid of all the carbonic acid gas out of the liquor before adding lime, the still was soon choked up with carbonate of lime; and this, he thought, would be the result of the double-effect system. He would also ask Mr. Ballantyne (if, as he understood him, he got rid of the arsenic in the strong liquor) what was the strength of the liquor through which he passed the gases in order to get rid of the arsenic. In the ordinary way, the arsenic was got out of the sulphuric acid after diluting it.

Mr. WALTER GRAFTON (Beckton) said he should be glad to know the strength of the acid used, and the quantity of acid per ton of sulphate made.

Mr. J. FERGUSON BELL (Derby) remarked that, having been permitted to inspect this plant some eighteen months since, he should like to congratulate Mr. Ballantyne on making it a success, because when he inspected it he was not altogether satisfied, and it struck him as being very complicated. The difference between this plant and the ordinary one was that Mr. Ballantyne worked under a vacuum, and, of course, by this means saved fuel. But the question occurred to him whether the complications and extra expense would not more than counterbalance the saving. Most gas-works raised steam at a very low cost—in their case, they estimated about 2s. per ton of sulphate sold as the cost of fuel, because they used only breeze for generating steam. This plant was very similar to others; the only special feature being the vacuum. One point brought forward was the overhead saturator. He had been working with one of this kind for some twelve months; and he could thoroughly recommend it, as very much less labour was involved. Of course, the sulphate fell down by gravity; and the only thing that had to be done was to open the valve every four or five hours, when it was dropped into the waggon, and wheeled into the sulphate stores. They worked the saturator with liquid of about 56° to 58°. Twaddel; and, strange to say, their salt came out very dry and very hot, and in a few hours was practically dry enough to be put into the bags and sold, if necessary. In their case, the saturator was formed of cast-iron plates lined with lead ½ inch thick. He did not think the author was quite correct in giving the life of a lead saturator as only two or three years. His experience was that it was more like ten years. At the end of this time, the lead was almost of the value of new; the only thing lost was the labour in making another saturator. There was one point about taking the arsenic out of the acid which he should like to have explained. A great many people used pyrites acid, from which the manufacturers took out the arsenic first; and the question occurred to him whether the manufacturers could not take the arsenic out cheaper than they could. Mr. Ballantyne had not given any figures showing the cost of working, or of plant, or of repairs; and it all came to a question of

£ s. d. The plant at Derby was a Colson, with an overhead saturator, which answered very well; and they had few repairs. When he inspected the plant at Hamilton, he came away with the firm conviction that it was much more complicated than his own, and could not recommend his Board to adopt it; but meantime Mr. Ballantyne might have considerably simplified it and improved the results.

Mr. R. G. SHADBOLT (Grantham) said there were one or two sulphate makers present who had been comparing notes; and they would like to know whether the total yield of sulphate per ton of coal carbonized was any greater by this method than that obtained by the ordinary process.

Mr. ROBERT WATSON (Doncaster) asked if Mr. Ballantyne would give the strength of the waste liquor. The worth of the whole process seemed to depend upon the value of the ammoniacal liquor.

Mr. J. H. TROUGHTON (Newmarket) said he should like to ask Mr. Ballantyne whether he found any nuisance arising from quenching the coke with the effluent liquor, and also if he could give them any definite data as to the number of times the draw-off valve at the bottom of the saturator became stopped, or if he had any trouble from that cause.

Mr. J. W. HELPS (Croydon) said he had had some experience in sulphate making with a great variety of plants during the last 25 years; and he should like to congratulate Mr. Ballantyne on his paper. At the same time, he could not help thinking it was a pity that he was not in a position to give some figures as to the cost of making sulphate by this new process as compared with, and the results obtained by, what might be termed the ordinary types. He agreed to a great extent with what Mr. Bell said; for the plant did appear to him, from the description and the drawings, to be somewhat complicated as compared with the old friends with which he was well acquainted, and which had given very good results in the past. Mr. Bell was perfectly right in saying that the cost of production of steam in gas-works was not very important, though, of course, every shilling saved was worth having. He could not quite reach a figure of 2s. per ton as the cost of fuel for sulphate making; but they got somewhere near to it. With regard to this process, it appeared that, beyond its novelty, the great claim made was that it was possible to use exhaust steam; but it seemed to him, knowing the amount of steam that had to be employed in making sulphate, that it was within the bounds of possibility they might have to put down some machinery to produce the exhaust steam. On their own works, they had a good many condensing engines; and the exhaust steam available would be scarcely sufficient to do all the work which would be necessary. They must not forget, also, that this plant necessitated the use of an engine and exhauster for producing the vacuum; and that machinery would require steam as well. If they took into consideration the large amount of extra capital which must be necessary to put down such a complicated plant, and the sum required for doing certain other extra work, he imagined there would be very little saving in the end. He thought Mr. Ballantyne possibly would, if he had had experience of sulphate making at Hamilton with other processes, be able to give some figures as to what the £ s. d. advantages of this system might be over those he had previously used.

Mr. R. BRUCE ANDERSON (London) suggested that Mr. Ballantyne might with advantage peruse the papers read before the Gas Institute in 1887, with the compiling of which he had something to do, having conducted some of the experiments with the late Colonel Croll. Having put down a reciprocating exhauster, they drew the products of combustion from the furnace through a Coffey still, and then passed the products through a saturator of the open type. The mechanical arrangements were very adverse to getting advantageous results; but at the time they concluded that they got an increased yield of sulphate of ammonia per ton. Where it came from, however, they could not exactly ascertain. Mr. Ballantyne, with his vastly improved apparatus having these overhead saturators, and having an exhauster which did not cause oscillation so much as a reciprocating one, would have an opportunity of verifying and repeating the experiments tried by Colonel Croll and himself.

Mr. BALLANTYNE, in reply, said with reference to the holes in the distributors of the saturators, he spoke from personal observation, because he had had experience of sulphate making for the last twenty years; and his experience was that, with ordinary lead saturators, the holes got torn away in a very short time indeed, and widened. No doubt, as Mr. Leather pointed out, there was friction with gases under vacuum as well as under pressure; but being under a vacuum, the friction must be much less, and therefore the destruction of the holes could not be so great or so rapid. The thickness of the copper in the saturator was ¼ inch. The percentage of ammonia in the sulphate had been tested a great many times; and they found there was a keen demand for it—most of it being bought up for shipment to the West Indies direct. He considered that, unless there was something special about it, the demand would not have been so keen, and the sulphate not have been sent so far. They sold it according to sample; and the brokers seemed most anxious to get it. He rather thought one of the reasons was the freedom from moisture, because of the large crystals, which did not destroy the bags in which it was packed to the same extent as ordinary sulphate. They got an additional price for the extra percentage of ammonia. With regard to the life of lead saturators, he also spoke from experience. In Rothesay, where they erected new works and new sulphate plant, a lead saturator was put in by one of the best makers in Scotland, and at the end of two years, it was so weakened by contraction and the heat that it simply tore away at the corners, and had to be repaired. At the end of 3½ years, it had to be renewed. The lead was not worn; it was simply torn away, and became so contorted that it was past repair, and had to be replaced by a new one. He understood that cast-lead saturators did last longer; but he had not had any experience of them. With solid plate-lead ones, his experience was they did not last anything like the time Mr. Leather said; and he thought he must have had an extra good one, made in some special way—quite different to those they got at the present time in Scotland. He knew of another works not very far away where a lead saturator had been in use for not much more than three years; and it had to be renewed quite recently. The double-effect plant had not been in use as yet in any works. This was the first plant of its kind ever erected. It took a long time to develop; and the double-effect plant had not been put into actual practice. How it would work, he could not tell. The idea was, if possible, to utilize the heat in the waste gases for further distillation; and for this purpose, of course, the plant was very suitable, if it could be done. With regard to the strength of the acid, they did not reduce it at all; it was 144° Twaddel, common chamber acid, not diluted in any way. The makers who supplied them with the special acid were quite surprised that they were able to thoroughly eliminate all the arsenic without lowering its strength. They said they had to reduce it; and he understood that all makers had to do so, for the simple reason that they had to purchase the sulphide of iron to make sulphuretted hydrogen with which to precipitate the arsenic in the acid. In gas-works, they had sulphuretted hydrogen in the waste gas; and it was a means of using it up, and also saving the purifiers. But acid makers reduced their acid down to a certain strength, so as to take the arsenic out of it more readily, and so as not to waste the sulphuretted hydrogen they had to make. The reduction of the strength of the acid was simply from the commercial point of view. They found there was no difficulty whatever in taking it out at full strength, because there was plenty of the sulphuretted hydrogen in the gas. They simply allowed it to run through until all the arsenic was precipitated. When Mr. Bell saw the plant, he must confess that it was in a very crude state. It was simply a network of pipes, more like a spider's web than anything else. But at the time they were also trying an experiment to use the sulphuretted hydrogen, to catch it up with the sulphate of iron, in order to utilize it for a commercial purpose. This experiment, however, was a failure. The apparatus was in that stage when Mr. Bell saw it; and, of course, it necessitated a great many pipes, and made the plant look very complicated indeed. In its present state, all these pipes had been done away with. Everything was shown on the drawing, except the steam-pipes leading to the plant. They used coke breeze in the boilers, but had not enough to keep up steam altogether; and in this way there was a saving, because where one had to use coke there must be a considerable saving on this head. Where coke breeze was plentiful, the saving would not be so large; but yet it was not necessary to use so much of it. It was possible to use up the exhaust steam. Of course, if there was no exhaust steam, it altered the question; but in the majority of works the exhaust steam was not condensed—

it passed into the atmosphere and was wasted. With this plant, it could be turned to some good account, thereby saving not only fuel but labour as well. He had refrained from giving the cost of working, because it varied very much in different places. The great part of the cost was really the price at which the acid could be purchased. In one district it might be bought at 30s.; whereas in another it might be necessary to pay 40s. or even 50s., or, again, it might be got for 25s. It was therefore almost impossible to give the average cost of the process.

Mr. HELPS asked if Mr. Ballantyne could give the cost as compared with making the sulphate in his own district under the old processes.

Mr. BALLANTYNE replied that most of them used pan acid, not chamber acid. The acid was distilled in a platinum still, and part of the arsenic taken out; and this acid would cost somewhere about 45s. to 50s. They could buy common chamber or tower acid at 30s. to 35s., and get the same result; so that they actually had a saving of about 15s. per ton in the sulphate made by using common, cheap acid, as compared with partially refined acid. With regard to the quantity of ammonia taken out, he had not had a complete year's working, and was not able to state the amount; but, as near as he could make out, last year it would run about 30 lbs. of sulphate to the ton of coal carbonized, and this without taking out the fixed ammonia. In Scotch liquors, the fixed ammonia was a very small quantity, and did not more than pay the expense of taking it out; whereas with English liquor, he understood the fixed ammonia was from four to six times as great. With regard to quenching the coke with the spent liquor, this was, in fact, the only thing they could do with it, as they were not allowed, under any conditions whatever, to put it into the drains. There was a slight smell from the steam; but by making high enough quenching towers, it could be carried up into the atmosphere, and in this way any nuisance from the steam could be to a great extent overcome. The waste liquor was raised to an overhead tank by a pump, and then passed down into an old gasholder tank at the bottom, where the coke was quenched, and it was kept circulating between the overhead tank and the one at the bottom. He found that with this form of plant a man could do more work than with the ordinary plant, especially if he had to fish the sulphate out. With the vacuum plant, he had nothing to do but to open the discharger and take out the salt, and then go about and look after the valves and gauges, which was a very simple thing. He could see the whole operation from the floor, because there was a mirror put on at the top of the side glass to enable him to see the height of the liquor. In fact, the whole operation could be perfectly seen. With two men during the summer, they made this quantity of sulphate, or three men in the winter; but these men could make double the quantity of salt. If the still were big enough, and he had sufficient liquor to employ larger plant, the same amount of labour would produce double the quantity. It required about 19½ cwt. of acid to the ton of sulphate.

THE GAS AND WATER STOCK MARKET.

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DESCRIPTION PREPARED

BY

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The meter-house and pumping-station buildings are two separate constructions, each, however, situated close to the gasholder. In design and general character, they are similar; and the same theory with regard to their construction has been carried out as was the case with the retort-house and the coal-store block of buildings—namely, the roof is entirely supported upon a series of piers of brickwork (in this case 2 ft. 3½ in. square); the intervening space being filled in with brickwork of as thin a description as possible—namely, 14-inch work for a height of 18 feet.

The basement work of these buildings consists of brickwork set in cement mortar, 23 inches thick, with pilasters as drawn. At a point 4 ft. 9 in. above the ground-line on the gasholder side, a stone plinth course encircles the building, forming also the base of the rising pilasters. The latter appear both internally and externally, and more substantially rivet the piers supporting the main-roof girders. They consist of columns of brickwork. The intervening space between the pilasters is mostly occupied by windows; the brickwork intervening being 14 inches thick. Above the capitals of the pilasters, a string-course (consisting of stone, 9½ inches thick) encircles the building. Over this, a brick frieze course, 2 ft. 3 in. deep, and a stone cornice surmounted by a cast-iron moulded gutter completes the upper part of the walls of these buildings.

Plate No. 24 shows elevations, plans, and sections of both the meter-house and the pumping-station buildings. The floor-level is purposely arranged to be above the general yard level; and beneath the floor is a half-sunk basement. In the case of the meter-house, this is about 10 ft. 9 in. deep. This basement is lighted and ventilated by means of semi-elliptical openings on both sides, filled in with iron railings, so that any escaping gas from the connections beneath is quickly dispersed by the flow of air through and through the basement. The purifier-house railway runs immediately along one side of these buildings; and on this side the openings communicating with the basement are carried down to the rail-level. On the opposite (or gasholder) side, where the ground-line is 3 ft. 11 in. below the floor-line, the openings are carried to within 3 inches of the ground-level.

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The principals consist of two 3½ inch by 3½ inch by ⅜ inch angle-steel front and back flanges, circled to the radius shown, with 2½ inch by ½ inch flat diagonal bars riveted between with ¾ inch rivets. They are 2 feet wide at the root, with a gradual taper to 16 inches at a point 5 ft. 6 in. from the longitudinal centre line of the building, and rising 16 feet from the base of the shoe, or 10 feet above the eaves-level or the top of the brick walls. The continuing flat girder, which is 11 feet long, is also 16 inches in depth, and similar in construction to the main rafters as far as substance and details are concerned.

Spaced about 3 ft. 6 in. apart, radially, on each principal, double T steel struts, of 6 inch by 3 inch by ⅜ inch section, are inserted between the top and bottom flanges of the principal. These are riveted back to back and to the web of the top and bottom flanges. The principals are spaced 18 ft. 6¾ in. apart along the length of the building; the hip-ends being formed of half principals of similar form and section in the usual way. The side walls of the building are carried up 6 feet above the shoes.

The base of each principal consists of a ½-inch plate 2 feet square, to which is riveted a bent and joggled 5 inch by 5 inch by ⅝ inch angle-steel (fig. 2). These angle-steels are so placed that the angles forming the top and bottom flanges of the curved member drop into the pocket thus formed; the base being further stiffened by means of a ½ inch web-plate and a front and back ⅜ inch gusset plate (fig. 6). The holding-down bolts pass through the flange of the 5 inch by 5 inch angle-frames, as well as the ½ inch base-plate. The junction of the rising end of the principals with the transverse horizontal girder and the longitudinal girders is secured by means of ½ inch junction plates (as shown in fig. 1) on the top and bottom sides, as well as being bolted through the end webs of the respective parts.

The central bay between the deck light louvre (fig. 1) is framed by means of two lines of longitudinal latticed girders (fig. 3) in all 92 ft. 10 in. long, placed 11 feet apart, centre to centre—forming the opening beneath the skylight and the frame upon which the skylight members are made to rest. These girders are 16 inches deep, and similar both in section and construction to the main rafters, excepting that their ends are joggled to fit in between the flanges of the curved girders, and are provided with a ⅜ inch cut-web plate. These girders, each about 19 feet long over all, are further stiffened by two 6 in. by 3 in. by ⅜ in. T steel struts riveted back to back—one strut being placed under each point where the framework of the skylight rests.

The skylight is supported by, and is comprised of, 3½ inch by 3½ inch by ⅜ inch T steel framed rafters supported at their outer ends by means of vertical standards of the same section, and internally by means of a bent T bar (as shown); the whole being secured together by means of fish-plates and angle-cleats. The lower ends, resting upon the longitudinal girders, are riveted to the flanges of the same. One of each of these principals is provided at about 6 ft. 2¼ in. centres transversely (see fig. 3).

Inverted angle steels are riveted—one near the ridge and the other at the outer extremity, secured to the backs of the purlins by means of 3 inch by 3 inch by ⅜ inch angle-ears, 7 inches long. Upon the upper table of these angle steel purlins, T steel astragals for supporting the glass in the roof are secured by means of countersunk rivets. The astragals consist of 1½ inch by 1½ inch by ¼ inch T steel rafters; a portion of the web being cut out at the lower end and the table turned up so as to prevent the glass sliding out of the rafters. The glass rests upon a putty bed on the internal flanges of these steel astragals; and to prevent wind pressure from beneath disturbing the glass, the webs of the astragals are drilled, and wood pegs driven through, to hold the glass in position. The whole is finally enclosed and covered with putty in the usual way.

The wood ridge occupies the apex of the roof, and has a lead flashing over its entire length, with the aprons folding down on either side. Between the upper side of the main curved girders and the under side of the T steel rafter forming the louvre roof, wooden glazed frames are inserted between the T steel standards, secured with coach-screws, and the whole made weather tight. The space between the underside of the glazing and the back of the angle purlin forming the louvre roof is left open throughout the entire length for ventilation; the glass being projected sufficiently forward to prevent the wind blowing rain or snow thereunder. The roof is covered with small slates, nailed upon close boarding; the boarding being nailed to 9 inch by 3 inch wood purlins running longitudinally with the building. These purlins are supported by means of 6 inch by 4 inch by ⅜ inch T steel trussed bars (see fig. 4); the trussing consisting of two 1⅛ inch diameter struts and ¾ inch tension-rods. A ⅝-inch tension-rod is also inserted from the bottom of the strut post to the inner or lower flange of the main rafters. Diagonally, this bracing is also stayed by means of ⅝-inch diameter rods—seen better in the elevation of the roof—the angle at which some of the simple trussed rafters would necessarily lie (following the curve of the roof) necessitating this precaution.

The pumping-station roof is shorter in the length than the meter-house, although the buildings are the same length over all. As it was intended to employ gas-engines for the pumping exhausters, provision was made for placing the tanks at either end of the pumping-station building—as shown on the north and south elevations and the sectional engraving. These tanks form the roof at each end, and are placed sufficiently high to ensure a satisfactory flow and return to the gas-engine cylinders. They are also made to receive the rain water from the roof of the pumping station; there being proper provision for sludge-taps and overflows and water supply when the same requires to be used for their respective purposes.

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it passed into the atmosphere and was wasted. With this plant, it could be turned to some good account, thereby saving not only fuel but labour as well. He had refrained from giving the cost of working, because it varied very much in different places. The great part of the cost was really the price at which the acid could be purchased. In one district it might be bought at 30s.; whereas in another it might be necessary to pay 40s. or even 50s., or, again, it might be got for 25s. It was therefore almost impossible to give the average cost of the process.

Mr. HELPS asked if Mr. Ballantyne could give the cost as compared with making the sulphate in his own district under the old processes.

Mr. BALLANTYNE replied that most of them used pan acid, not chamber acid. The acid was distilled in a platinum still, and part of the arsenic taken out; and this acid would cost somewhere about 45s. to 50s. They could buy common chamber or tower acid at 30s. to 35s., and get the same result; so that they actually had a saving of about 15s. per ton in the sulphate made by using common, cheap acid, as compared with partially refined acid. With regard to the quantity of ammonia taken out, he had not had a complete year's working, and was not able to state the amount; but, as near as he could make out, last year it would run about 30 lbs. of sulphate to the ton of coal carbonized, and this without taking out the fixed ammonia. In Scotch liquors, the fixed ammonia was a very small quantity, and did not more than pay the expense of taking it out; whereas with English liquor, he understood the fixed ammonia was from four to six times as great. With regard to quenching the coke with the spent liquor, this was, in fact, the only thing they could do with it, as they were not allowed, under any conditions whatever, to put it into the drains. There was a slight smell from the steam; but by making high enough quenching towers, it could be carried up into the atmosphere, and in this way any nuisance from the steam could be to a great extent overcome. The waste liquor was raised to an overhead tank by a pump, and then passed down into an old gasholder tank at the bottom, where the coke was quenched, and it was kept circulating between the overhead tank and the one at the bottom. He found that with this form of plant a man could do more work than with the ordinary plant, especially if he had to fish the sulphate out. With the vacuum plant, he had nothing to do but to open the discharger and take out the salt, and then go about and look after the valves and gauges, which was a very simple thing. He could see the whole operation from the floor, because there was a mirror put on at the top of the side glass to enable him to see the height of the liquor. In fact, the whole operation could be perfectly seen. With two men during the summer, they made this quantity of sulphate, or three men in the winter; but these men could make double the quantity of salt. If the still were big enough, and he had sufficient liquor to employ larger plant, the same amount of labour would produce double the quantity. It required about 19½ cwt. of acid to the ton of sulphate.

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Spaced about 3 ft. 6 in. apart, radially, on each principal, double T steel struts, of 6 inch by 3 inch by ⅜ inch section, are inserted between the top and bottom flanges of the principal. These are riveted back to back and to the web of the top and bottom flanges. The principals are spaced 18 ft. 6¾ in. apart along the length of the building; the hip-ends being formed of half principals of similar form and section in the usual way. The side walls of the building are carried up 6 feet above the shoes.

The base of each principal consists of a ½-inch plate 2 feet square, to which is riveted a bent and joggled 5 inch by 5 inch by ⅝ inch angle-steel (fig. 2). These angle-steels are so placed that the angles forming the top and bottom flanges of the curved member drop into the pocket thus formed; the base being further stiffened by means of a ½ inch web-plate and a front and back ⅜ inch gusset plate (fig. 6). The holding-down bolts pass through the flange of the 5 inch by 5 inch angle-frames, as well as the ½ inch base-plate. The junction of the rising end of the principals with the transverse horizontal girder and the longitudinal girders is secured by means of ½ inch junction plates (as shown in fig. 1) on the top and bottom sides, as well as being bolted through the end webs of the respective parts.

The central bay between the deck light louvre (fig. 1) is framed by means of two lines of longitudinal latticed girders (fig. 3) in all 92 ft. 10 in. long, placed 11 feet apart, centre to centre—forming the opening beneath the skylight and the frame upon which the skylight members are made to rest. These girders are 16 inches deep, and similar both in section and construction to the main rafters, excepting that their ends are joggled to fit in between the flanges of the curved girders, and are provided with a ⅜ inch cut-web plate. These girders, each about 19 feet long over all, are further stiffened by two 6 in. by 3 in. by ⅜ in. T steel struts riveted back to back—one strut being placed under each point where the framework of the skylight rests.

The skylight is supported by, and is comprised of, 3½ inch by 3½ inch by ⅜ inch T steel framed rafters supported at their outer ends by means of vertical standards of the same section, and internally by means of a bent T bar (as shown); the whole being secured together by means of fish-plates and angle-cleats. The lower ends, resting upon the longitudinal girders, are riveted to the flanges of the same. One of each of these principals is provided at about 6 ft. 2¼ in. centres transversely (see fig. 3).

Inverted angle steels are riveted—one near the ridge and the other at the outer extremity, secured to the backs of the purlins by means of 3 inch by 3 inch by ⅜ inch angle-ears, 7 inches long. Upon the upper table of these angle steel purlins, T steel astragals for supporting the glass in the roof are secured by means of countersunk rivets. The astragals consist of 1½ inch by 1½ inch by ¼ inch T steel rafters; a portion of the web being cut out at the lower end and the table turned up so as to prevent the glass sliding out of the rafters. The glass rests upon a putty bed on the internal flanges of these steel astragals; and to prevent wind pressure from beneath disturbing the glass, the webs of the astragals are drilled, and wood pegs driven through, to hold the glass in position. The whole is finally enclosed and covered with putty in the usual way.

The wood ridge occupies the apex of the roof, and has a lead flashing over its entire length, with the aprons folding down on either side. Between the upper side of the main curved girders and the under side of the T steel rafter forming the louvre roof, wooden glazed frames are inserted between the T steel standards, secured with coach-screws, and the whole made weather tight. The space between the underside of the glazing and the back of the angle purlin forming the louvre roof is left open throughout the entire length for ventilation; the glass being projected sufficiently forward to prevent the wind blowing rain or snow thereunder. The roof is covered with small slates, nailed upon close boarding; the boarding being nailed to 9 inch by 3 inch wood purlins running longitudinally with the building. These purlins are supported by means of 6 inch by 4 inch by ⅜ inch T steel trussed bars (see fig. 4); the trussing consisting of two 1⅛ inch diameter struts and ¾ inch tension-rods. A ⅝-inch tension-rod is also inserted from the bottom of the strut post to the inner or lower flange of the main rafters. Diagonally, this bracing is also stayed by means of ⅝-inch diameter rods—seen better in the elevation of the roof—the angle at which some of the simple trussed rafters would necessarily lie (following the curve of the roof) necessitating this precaution.

The pumping-station roof is shorter in the length than the meter-house, although the buildings are the same length over all. As it was intended to employ gas-engines for the pumping exhausters, provision was made for placing the tanks at either end of the pumping-station building—as shown on the north and south elevations and the sectional engraving. These tanks form the roof at each end, and are placed sufficiently high to ensure a satisfactory flow and return to the gas-engine cylinders. They are also made to receive the rain water from the roof of the pumping station; there being proper provision for sludge-taps and overflows and water supply when the same requires to be used for their respective purposes.

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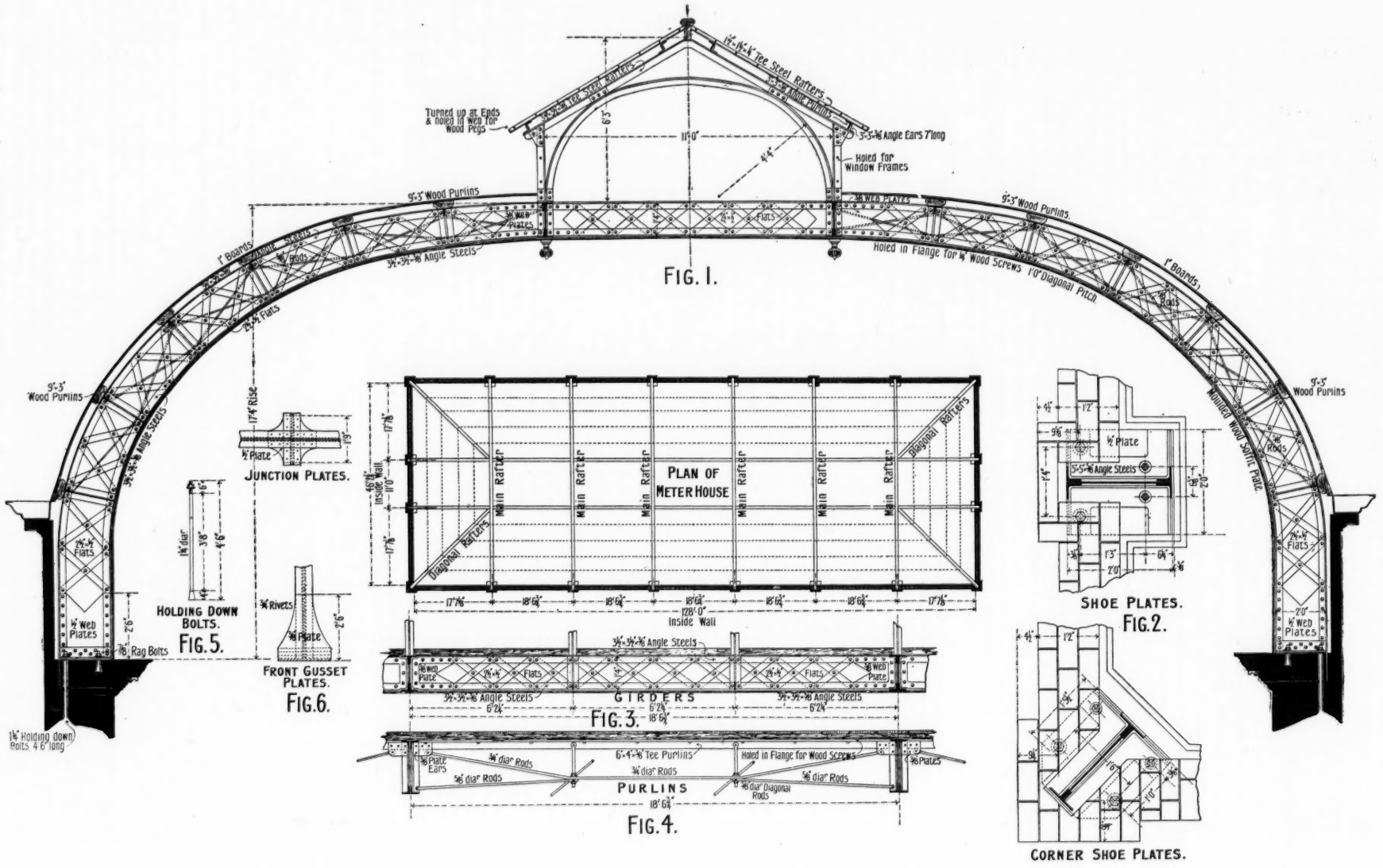
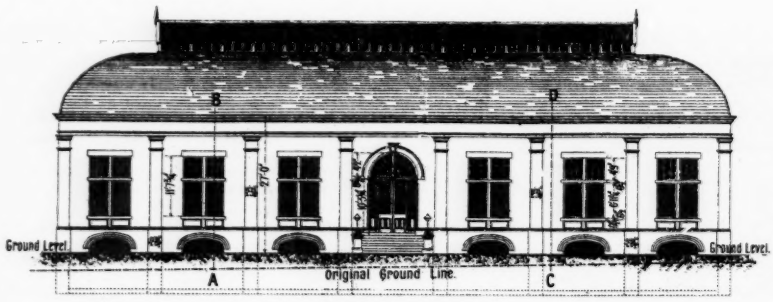
The Granton Works of the Edinburgh and Leith Gas Commissioners.



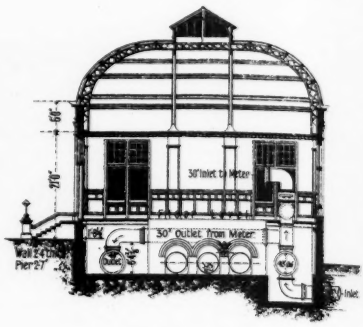
DETAILS OF THE ROOFS FOR THE STATION-METER HOUSE AND THE PUMPING STATION.

The Granton Works of the Edinburgh

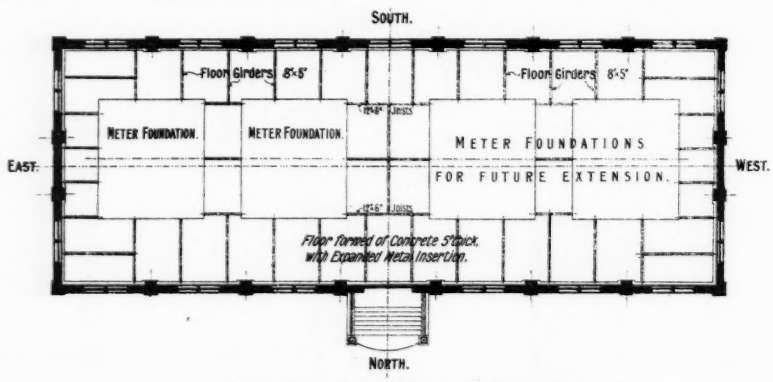
Meter House and Pumping



NORTH ELEVATION.

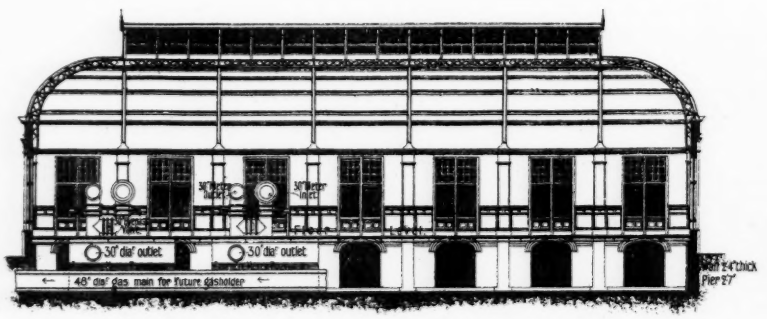


TRANSVERSE SECTION.

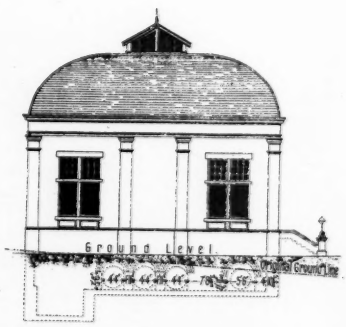


PLAN SHEWING FLOOR GIRDERS AND FOUNDATIONS.

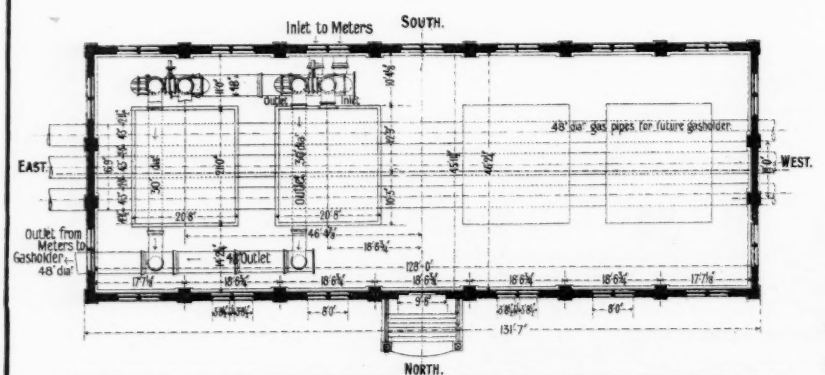
METER HOUSE.



LONGITUDINAL SECTION.

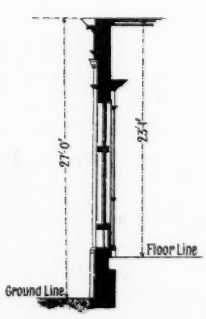


EAST END ELEVATION.

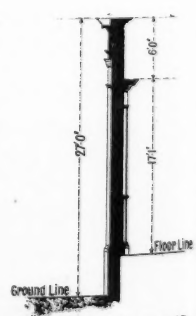


LOW LEVEL RAILWAY.

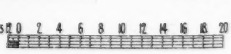
PLAN SHEWING METER FOUNDATIONS AND CONNECTIONS.



SECTION OF WALL AT AB.



SECTION OF WALL AT CD.



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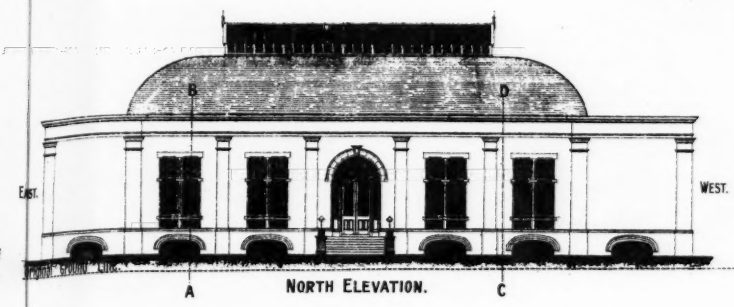
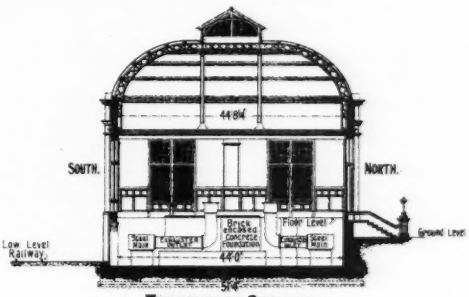
Pumping Station Buildings.

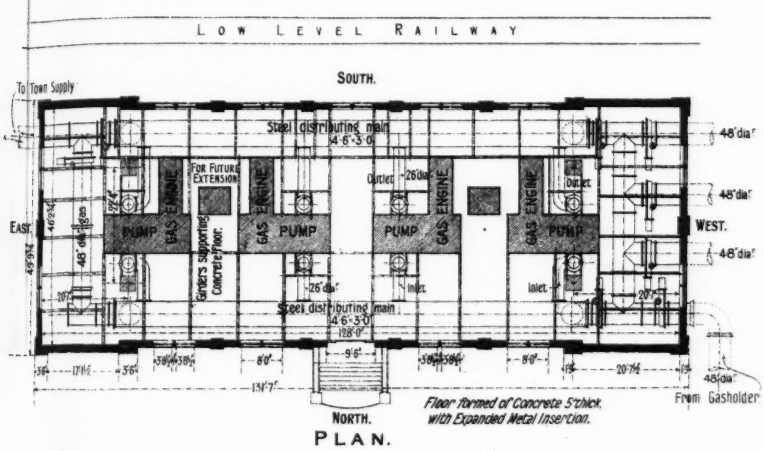
No. 24.



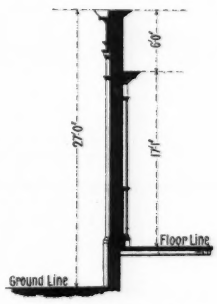
NORTH ELEVATION.



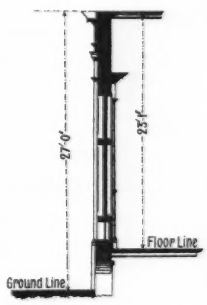
TRANSVERSE SECTION.



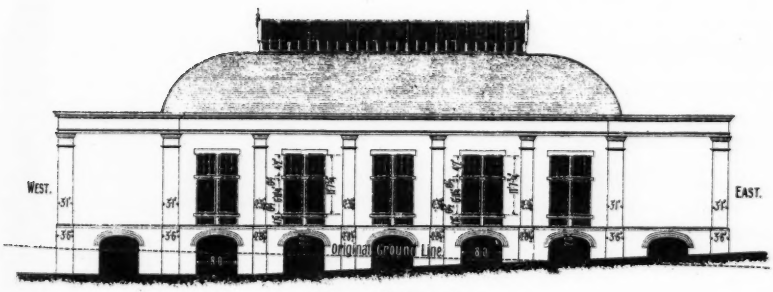
PLAN.



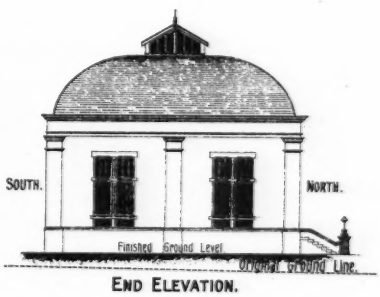
SECTION OF WALL AT CD.



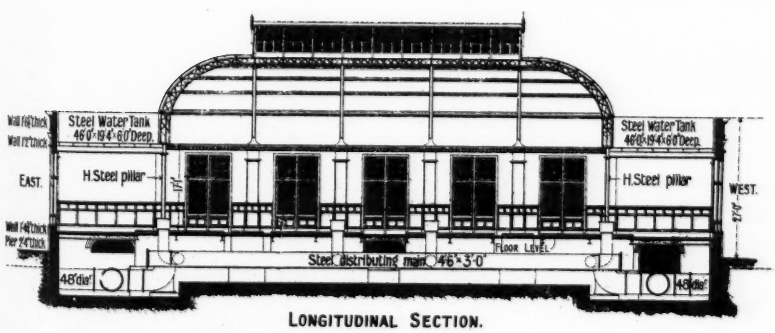
SECTION OF WALL AT AB.



SOUTH ELEVATION.



END ELEVATION.



LONGITUDINAL SECTION.

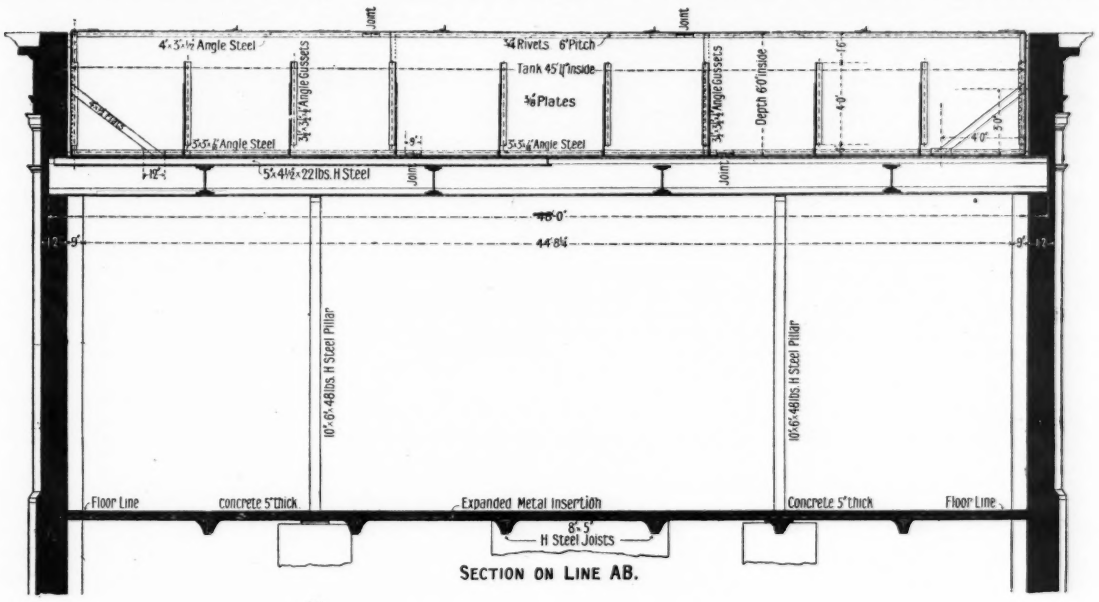
PUMPING STATION

Inches 0 2 4 6 8 10 20 30 40 50 Feet.

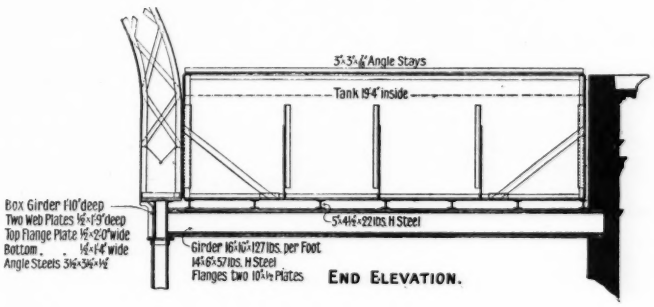
WALTER RALPH HERRING,

M.INST.C.E., *ENGINEER.*

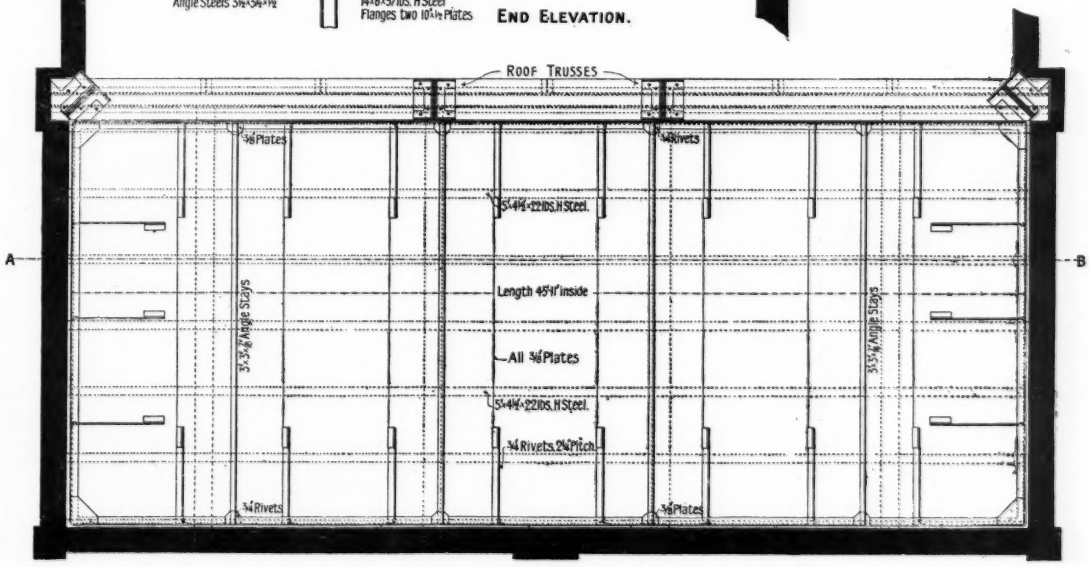
The Granton Works of the Edinburgh and Leith Gas Commissioners.



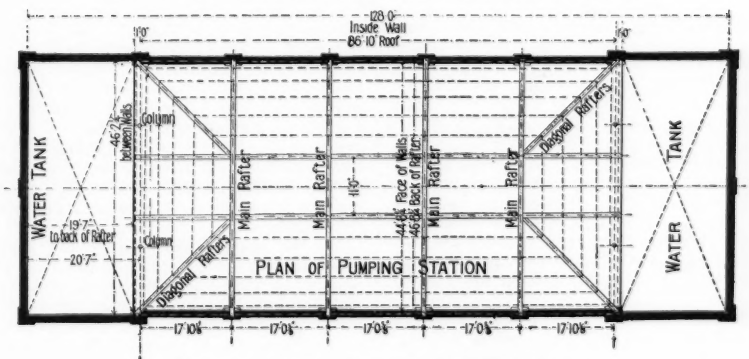
SECTION ON LINE AB.


3"×3"×⅜" Angle Stays
Tank 19'4" Inside
5"×4½"×22 lbs. H Steel
Box Girder F10" deep
Two Web Plates ½"×9'0" deep
Top Flange Plate ½"×2'0" wide
Bottom " ½"×1'4" wide
Angle Steels 3½"×3½"×½"
Girder 16½"×127 lbs. per Foot
14"×6"×57 lbs. H Steel
Flanges two 10"×½" Plates

END ELEVATION.



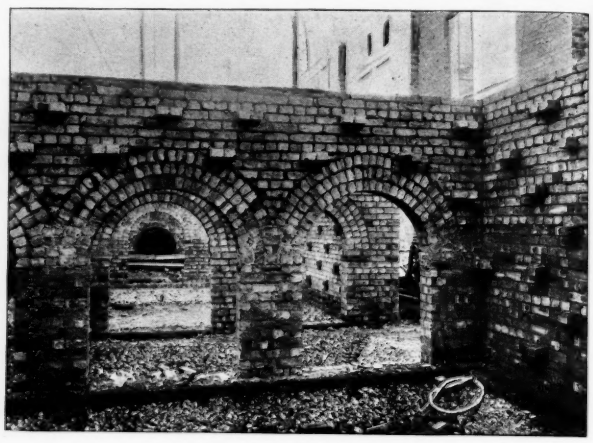
DETAILS OF THE WATER TANK FOR THE PUMPING STATION.



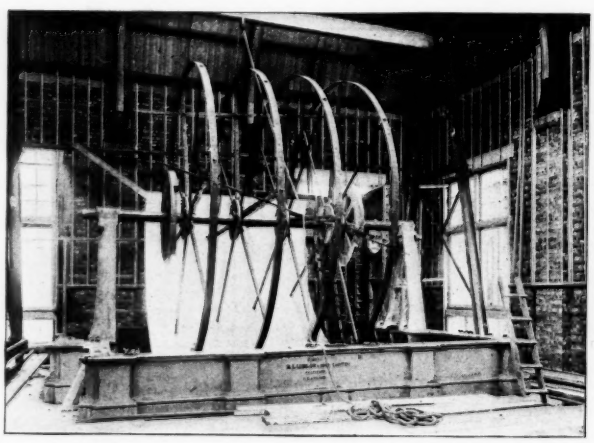
DETAILS OF THE PUMPING STATION ROOF.

The details of the tanks are shown on the engraving. They measure inside 45 ft. 11 in. long by 19 ft. 4 in. wide by 6 feet deep, and are composed of $\frac{3}{8}$-inch steel plates, riveted together in the usual way. They are composed of $\frac{3}{8}$-inch bottom plates, about 19 ft. 3 in. long by 5 ft. 3 in. wide, lap-jointed and single riveted by means of $\frac{3}{4}$-inch rivets, $2\frac{1}{4}$ inches pitch, throughout. The bottom curb consists of a 3 inch by 3 inch by $\frac{7}{16}$ inch angle-steel frame riveted to the bottom by means of $\frac{3}{4}$-inch rivets, $2\frac{1}{4}$ inches pitch; and the side plates, $\frac{3}{8}$ inch thick, are also riveted with $\frac{3}{4}$-inch rivets, $2\frac{1}{4}$ inches pitch, to the bottom curb, and to a top angle curb of 4 inch by 3 inch by $\frac{1}{2}$ inch steel, with $\frac{3}{4}$-inch rivets, 6 inches pitch. The side plates are lap-jointed and secured by means of $\frac{3}{4}$-inch rivets, $2\frac{1}{4}$ inch pitch. The corners are also stiffened by means of 3 inch by 3 inch by $\frac{7}{16}$ inch angles, with $\frac{3}{4}$ inch rivets, $2\frac{1}{4}$ inch pitch. Transversely, the tank is stayed by means of four 3 inch by 3 inch by $\frac{7}{16}$ inch angle stays, riveted upon the top curb and spanning the breadth of 19 ft. 4 in. Internally, the side plates throughout are stayed by means of $3\frac{1}{2}$ inch by $3\frac{1}{2}$ inch by $\frac{1}{2}$ inch angle gussets steel riveted to the side plates by $\frac{3}{4}$ inch rivets, $2\frac{1}{4}$ inch pitch, to which are riveted, at an angle of about 30 degrees, 4 inch by $\frac{1}{2}$ inch flat ties; the lower ends of these ties being secured to angle-cleats riveted to the bottom of the tank. The tanks are supported at a level of 17 ft. 2 in. from the pumping-station machinery house level. Spanning the building transversely, 46 ft. $2\frac{1}{4}$ in., a box-plated girder is provided, resting on stone templates built into the wall at each end. This girder is further supported upon two 10 inch by 6 inch by 48 lbs. H steel pillars. The box-girder is 1 ft. 10 in. deep, composed of a top and bottom $\frac{1}{2}$ inch flange plate; the top flange being 2 feet wide, the lower flange 1 ft. 4 in. wide, secured by means of $3\frac{1}{2}$ inch by $3\frac{1}{2}$ inch by $\frac{1}{2}$ inch angle steels to two $\frac{1}{2}$ inch by 1 ft. 9 in. web-plates. The top flange of this girder was made 2 feet wide in order to receive the base of the half-end curved rafters forming the roof; this plate being further stiffened by means of 6 inch by 3 inch by $\frac{1}{2}$ inch bent and joggled T steel struts, fixed 5 ft. 6 in. apart. From the main girders into the wall at either end four 16 inch by 10 inch by 127 lbs. steel joists, consisting of a section 14 inch by 6 inch by 57 lbs. H steel, stiffened by means of two 10 inch by $\frac{1}{2}$ inch plates riveted to the top and bottom flanges, are made to rest within

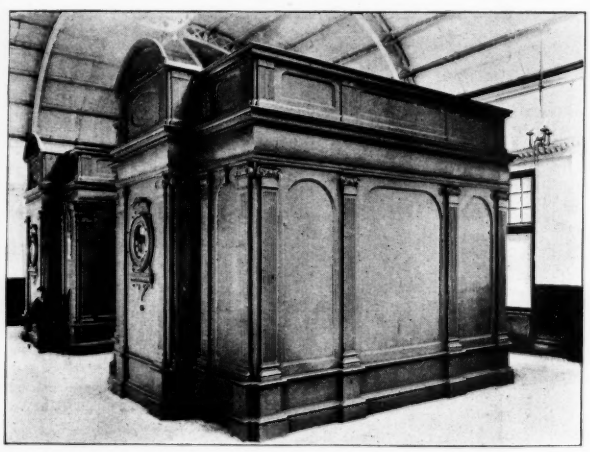
PHOTOGRAPH No. 120.—Brick encased concrete mass foundations for the station-meters with three 48-inch future gasholder outlets passing there-through; the 30-inch meter outlets being also embedded and brought from back to front.



PHOTOGRAPH No. 121.—Interior of the brick casements for the meter foundations and future extensions.



PHOTOGRAPH No. 122.—The meter-casing, showing the method of supporting the drum-shaft.



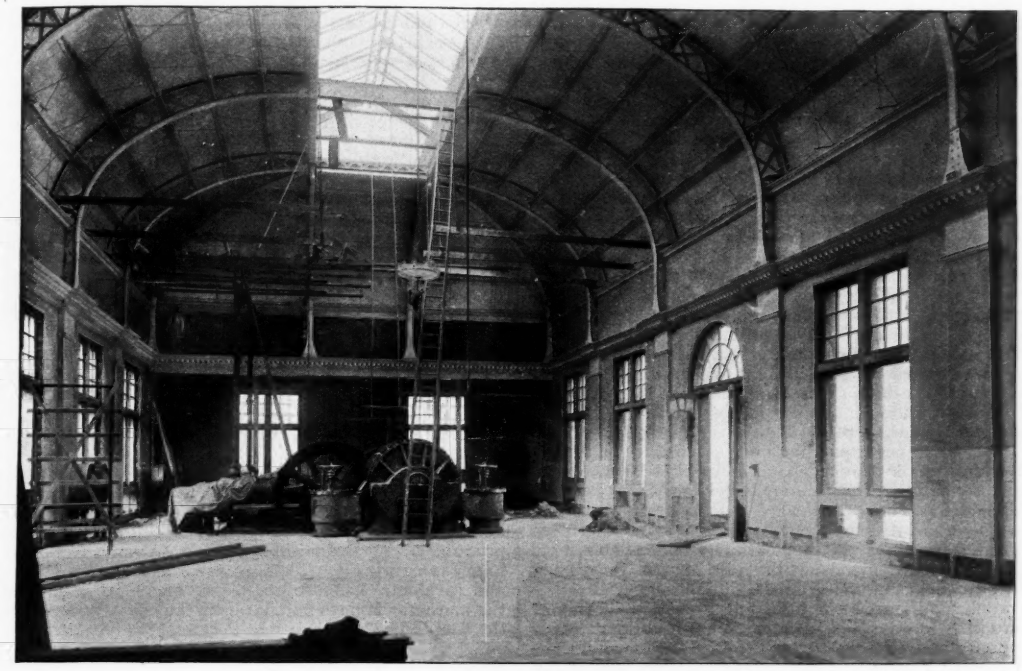
PHOTOGRAPH No. 123.—Exterior casing of the station-meters (from own designs).

the main transverse girder at one side, and upon stone templates resting upon, and built into, the wall of the building on the other. Upon these are laid 5 inch by $4\frac{1}{2}$ inch by 22 lbs. H steel joists, spaced 3 ft. 1 in. apart, forming the floor for the bottom of these tanks.

The meter-house is in close proximity to the outlet end of the purifier-house. The gas, in two streams of 30-inch pipes, coming from the purifiers is collected into one 48-inch diameter main; and, by means of an arrangement of valves and connections, it can be distributed to one or two of the existing meters, or can be made to flow through subsequent meters when an extension of the works has taken place. At the present time, there are two meters, each of 200,000 cubic feet per hour capacity, the general arrangement of the connections of which are shown upon Plate No. 24.

The outlets from the meters descend from the back in the usual way, and pass through the concrete of the meter foundation to the front, where they discharge into one 48-inch diameter main common to both, which, immediately outside the building, communicates with the gasholder inlet. The relative position of the pumping-station and the meter-house is such that future gasholder outlets communicating with the pumping-station must pass under the same. Provision has, therefore, been made in the meter foundations—in fact, the connections have been placed in position—for three lines of 48-inch pipes forming outlets to three future gasholders. These pipes have been permanently laid immediately beneath the meter foundations; the foundation itself consisting of a brick encased concrete mass, with the 48-inch connections imbedded within the solid concrete. Future extensions can, therefore, take place without any disturbance of the existing system; and while the foundations for the two additional meters which will be required when the next section of the works is constructed have not been put in, the walls to enclose the concrete forming the foundations have been built so as to give the necessary support for the joists forming the meter-house floor.

The meter-house floor is constructed upon the expanded metal



PHOTOGRAPH No. 124.—Interior of the pumping station (the meter house is similarly treated).

principle, and the joists supporting the concrete are shown on Plate No. 24. The floor joists—except over the central gangway between the meter foundations, where they are 12 inch by 6 inch—consist of 8 inch by 5 inch by 30 lbs. steel joists, supported upon a 4½ inch projection from the main walls of the building, and resting upon the brickwork forming the casement of the meter foundations. Between these joists, centre boarding was placed and fixed, and expanded metal (consisting of sheets having 3 inch meshes and strands gauging ¼ inch by ⅛ inch) was laid upon these boards. Concrete, 5 inches thick (composed of five parts of broken stone, one part of sand, and one part of portland cement), was laid thereupon. The surface was brought to a true and smooth level and finished in the ordinary way with a mixture of three parts of fine granite chips to one part of portland cement.

The meter tanks themselves are entirely above the floor-line of the meter-house. The meter casings are in cast iron of the square type, and measuring approximately 21 feet long by 18 feet broad by 19 ft. 6 in. high. They have been constructed to our own design by Messrs. R. Laidlaw and Son, of Glasgow; but they need not be further described than the photograph, which generally illustrates their outward shape and form. The meters themselves are each capable of passing 2000 cubic feet per revolution of the drum, which is 16 feet in diameter and 16 feet long, and is constructed in the usual form of No. 15 B.W.G. sheets and supported upon a 7-inch diameter turned shaft. The bearings supporting the shaft are of gun metal, and rest upon strong A framed brackets supported from the bottom of the meter-tanks. The drum, therefore, receives direct support without being in any way dependent upon the meter casing for its steadiness. The bearings are lubricated by means of small pumps fixed on the crown casing at the front and back of the meter. The index is fitted with seven dials, registering up to 100 millions, with tell-tale and clock. The dial-plate and all the outside fittings are made of aluminium.

The pressure-gauges in connection with the double set of purifiers, the meters, and the gasholder are all concentrated into one group in a suitable case in the meter-house; similar connections also passing to the exhauster-house through the pipe-trenches. These gauge-pipes are laid in such a manner that steam can at any time be employed for cleaning any obstruction that may accumulate in the pipes. By means of double cocks and a flexible steam connection, communication with the gauge can at any time be shut off, the steam connected to the spare cock, and the steam pressure applied—the obstruction being blown back into the interior of the plant with which the gauge-pipe communicates. Test-pipes and bib-cocks are also provided on each connection for the convenience of testing for impurities, &c., under cover without carrying the apparatus in and around the purifiers in rough and stormy weather.

THE FISCAL PROBLEM AND THE COKE TRADE.

It appears to be a reasonable proposition that those who are directly interested in the ascertainment of the correct answer to the fiscal problem posed by the Colonial Secretary, with the concurrence of his colleagues, should bring to the task of its solution such particular knowledge of the course of trade as they may have acquired in the conduct of their own business affairs. As we have already admitted in editorial notices of Mr. Chamberlain's action in this regard, those who are responsible for the safe keeping and legitimate extension of the British gas industry, have, both as citizens and as large employers of labour, a very considerable and immediate interest in national fiscal questions. Now that the whole system of the financial relations of the British Empire is thrown into the melting-pot, for eventual recasting either in the old moulds or into new shapes, or a mixture of the two, we are quite sure that regular readers of the "JOURNAL" will expect to find in it from time to time some references to those aspects of the matter which seem to appeal specially to them in one capacity or another.

We shall meanwhile be glad to receive, from all and sundry who may be qualified to supply them, statements of significant facts of experience, and pertinent observations, which may tend to elucidate the multitudinous mysteries that surround and obscure the operations of the domestic and international trades connected with the gas industry, so far as these bear upon the issue. Although the professional leaders of the working classes of the United Kingdom—who are neither employers, nor possessed of any commercial knowledge—have rushed, according to their manner, to declare what the "workers" ought to think of what we will term for brevity's sake the "Chamberlain Problem," there is no reason to suppose that the weight of public opinion throughout the country will not be affected by the ordinary processes of inquiry, and by the judgment of deservedly influential persons. Whatever the immediate and direct influence of employers and heads of industrial establishments over the minds of their work-people, and in their own social circles, it is at least desirable that they should take every necessary step to form their own judgment on the evidence.

We desire to keep our own treatment of the problem within the strict limits of its bearings upon the gas industry, but find, at the outset, great difficulty in doing so, and yet preserving the breadth of the basis upon which so vast and complex a subject must be posed. Up to the present time, this basis has nowhere been defined. There have been two fragmentary discussions of the subject in the House of Commons, and one in the House of Lords; but still the very elements of the polemic have not emerged. The common ground essential for any fruitful controversy is not marked out, much less occupied by contending sides. It is necessary, however, to make an attempt in the sense of laying out the field, which requires the formulation of certain assumptions. It must be sheer waste of time, for instance, to argue with those who hold that there is nothing to talk about, seeing that everything is for the best in the best of all possible fiscal systems. Let us assume, rather, that the case is otherwise, and that the time has come for a thorough reconsideration of our national system of rates and taxes.

It is no assumption, but the fact, that, as regards rates, or

revenue raised for local government purposes, a system hundreds of years old, long outworn, and full of inconsistencies and inequalities, is only worked at all by means of subventions from the National Treasury. The arrangement is a make-shift, and the only real obstacle in the way of its radical reformation is the common knowledge that this would involve large transfers of charge from local to national resources, which latter are inadequate to bear any additional burden of the kind. The modern cry for old-age pensions is, at bottom, merely a demand for making poor relief a national instead of a local charge. The change in the distribution of the population, and also of its character from fixed to shifting, since the enactment of the Poor Law, is sufficient reason for this demand. No proposed alteration of the local revenue system could be so astounding as the alternative proposition that arrangements originally devised to suit the England of Elizabeth can, by continuous patching, be made satisfactory for the England of to-day and the infinite future.

Let it be further assumed that no reformation of local rating can be effected without a readjustment of national taxation, which means either a thorough redistribution of the principal applications of the existing tax fund, or its enlargement. The former is not to be hoped for, although certain economies may be practicable, which is not to say that they will ever be practised. A growing empire, like any other expanding business, cannot be run on savings. Reckless extravagance apart, a trader who discovers the need for retrenchment is within measurable distance of shutting shop altogether. The experience in administration of every local authority of a growing town can be cited to convince voters that, with all the desire for abstract economy conceivable, it is impossible to keep the demands on the rate fund in the way of decrease. The conclusion must be drawn, therefore, that the national taxation fund must be increased; and the only pertinent question here is as to ways and means. What additional taxes can be imposed; and who are to pay them? For it will not require deep inquiry among past and present Chancellors of the Exchequer to ascertain that the existing basis of British taxation is too small; that most of the old taxes have been carried to their highest point of productiveness; and that the principal direct taxes, on income and property succession, are already excessive. Mr. Chamberlain, in the assumed emergency, declares that the only expedient worth considering at all is an import duty on food, with preference for Indian and Colonial products. That this source of additional revenue would be adequate is obvious. That it would be expedient is the thing that is required to be demonstrated—not to the satisfaction of a special jury, but to the consent of the multitude. The attempt to do so is the boldest experiment in practical politics of our time. It is a repetition of the venture to answer the riddle of the Sphinx. What are the prospects of success?

Great interest was taken in advance in the undertaking of Lord Goschen to bring the subject before the House of Lords last week, on what may be described as an interim motion. It must be regretfully said that Lord Goschen's speech was disappointing, in that it begged the most important of all the questions raised by the conditions attaching to Mr. Chamberlain's suggestion, which is that of the incidence of any duty imposed in this way. Repeatedly, Lord Goschen called this "taxing the people's food;" whereas this is the very point to be ascertained by the fullest and freest exercise of all the knowledge and wit that can be brought to bear upon it. Will a British import duty on food, with the preference indicated, fall upon the consumer at all? If it does, and so far as it does, then it is a tax upon the people's food. But this is an effect not by any means to be taken for granted. Let us deal with this point first; and in discussing it, there will be found to be some light available from a very well-known experience of the gas industry.

The question here is whether, by offering a substantial preference (in the shape of a remission of the duty levied upon foreign sources of supply) to Indian and Colonial produce, the output of the latter would be so encouraged and increased that values would not be raised at all against the consumer. So impartial a witness as Earl Rosebery is of opinion that the answer to this question is in the affirmative. It is a matter respecting which anyone knowing the capacity for development of the Indian and Colonial output of food is equally competent to form an opinion. Lord Rosebery said this with the object of dispelling any idea that such duties would necessarily exert a protective effect upon the home production. Clearly, if prices are not raised in consequence of the duties, they cannot be protective. There is another reason why such duties would not necessarily raise prices against the consumer, in the existence of the Indian and Colonial preference. Whatever the amount of this, foreign producers would have to bear it, or lose their trade. They could only keep their British market by underselling Indian and Colonial supplies at least by the amount of the duty—perhaps a little more. Thus the effect of the duty might even be to cheapen supplies. In nowise would the home producer necessarily be protected, unless the amount of the duty were fixed so high as to exceed ordinary market fluctuations, which is clearly not within the scope of the hypothesis.

This argument, which appears to be sound, goes straight to the point of who bears a duty of this kind; and indicates the conclusion that in this case it would be the foreign producer, and him alone. That, we take it, is Mr. Chamberlain's object. Of course, if the duty were so heavy as to drive the foreigner out of the trade altogether, the duty would yield nothing. But then, again, the food of the people would not be taxed. The lesson of this conclusion is that the incidence of a duty of this character depends wholly upon the consideration of where the desire to trade originates. If the producer of a commodity which can only be put upon the market of his selection under certain conditions—namely, payment of duty—is under any compulsion to seek this market, he will submit to the conditions so long as he can, or so long as it suits him to do so. In this case, he will usually be found to have two prices for the same goods—the higher which he gets at home, and the lower for which he is content to export. On the other hand, if the product is one that is sought after—as to which the impulse to trade comes from the opposite direction—the seller will have only one price; and the buyers must pay their own expenses (freight, duties, and everything else), which eventually the consumer bears.

One specific example of this common operation of commerce is the London, Provincial, and Continental gas-coke trade. Beckton was the source of unmanageable supplies of coke, which were partly disposed of locally, and partly sent away to compete with other supplies of this fuel. Nor was Beckton the only source of coke which went the same way. At any rate, every such consignment of coke was sold for a price low enough for the purchaser to pay freight and dues to the Baltic, or railway charges into the country, and still make a profit by competing with the local supplies. In other words, these coke sales were at two prices—high for the home, and low for the export trade; and the difference (being the whole cost of exportation) was borne by the producers. As against this, can be set the illustration of the Durham gas coal trade. The buyers for exportation pay every duty and incidental expense on this commodity, which is no drug in the market. It does not matter to the colliery proprietor whether the coal is for Copenhagen or Portsmouth; he has the same price, which is not regulated by any consideration of dues to be paid on shipment or delivery.

Many other considerations might be advanced in regard to other aspects of the Chamberlain problem, such as why it should be esteemed the height of infamy to place a duty on the people's food, but quite proper to tax the people's drink and tobacco. Also, there is much to be said in regard to the effects of having something to give in exchange for concessions by foreigners, to whom Free Trade is an exploded superstition. The subject of Trusts, in connection with Protection, also calls for careful consideration. For the present, however, we must rest content with having ventilated one department of this most important problem, and with showing, by the history of the gas coke trade, that import duties do not necessarily hinder a trade in the taxed commodity, nor fall upon the consumer, even where (through the absence of a preference) they might have some protective action. This is a demonstration, not on "principle," to be settled by reference to Cobden, or Bright, or Sir Robert Peel, or anybody else; nor to doctrines and dogmas sixty years old. It is a fact of contemporaneous trade, and of the gas industry of this Free Trade country—or "Free Importing" country, as the Duke of Devonshire prefers to classify the existing arrangements. Professor Nicholson has admitted that to ascertain the incidence of any tax is a task of the utmost difficulty. Here, we venture to think, is a concrete example which has a force and meaning that nobody will gainsay. Mr. Chamberlain first showed his quality as a statesman in dealing with the Birmingham gas supply. He knows the terms on which Birmingham coke was sold in his time, and may be sold still; and he will be able to see in this two-price dealing the disproof of the presumption that a British import duty on food, with remission in favour of Indian and Colonial importations, is necessarily a tax upon the people's food.

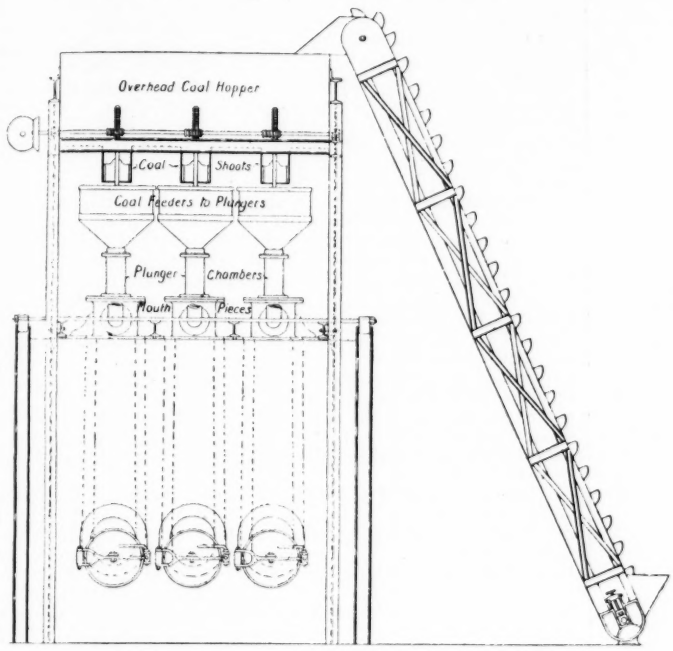
Field's "Analysis" for 1902.—The annual analysis of the accounts of the principal gas undertakings in England, Scotland, and Ireland, compiled and arranged by Mr. John W. Field, has just been issued. As before, the first section of the book is devoted to the accounts of the London and Suburban Gas Companies, and the second to those of Companies and Corporations in the Provinces, Scotland, and Ireland, for the year 1902. These are followed by three appendices—the first giving details of the coal carbonized and the oil and spirit used; the second, the amount of capital employed per 1000 cubic feet of gas supplied on days of maximum delivery; and the third, the number of ordinary and "automatic" consumers. The last is a very interesting compilation, which shows at a glance the extent to which the prepayment system of gas supply has grown. Taking the area served by the three London Companies alone, out of the 666,526 consumers at the close of the past year, 291,870 were on this system. The present is the 34th year of publication of the "Analysis," and therefore its characteristic features are too well known to need indicating. It may be assumed, in view of the announcement made in our columns on the 16th inst., that it will be the last to be issued by the Compiler from the offices of the Company with whom he has been so long associated; but we may nevertheless venture to express the hope that very many succeeding publications of the "Analysis" may have his immediate personal supervision, to ensure a continuance of the accuracy which has rendered his work so valuable in the past to all engaged in the great industry of gas supply.

THE SETTLE-PADFIELD CARBONIZING PROCESS.

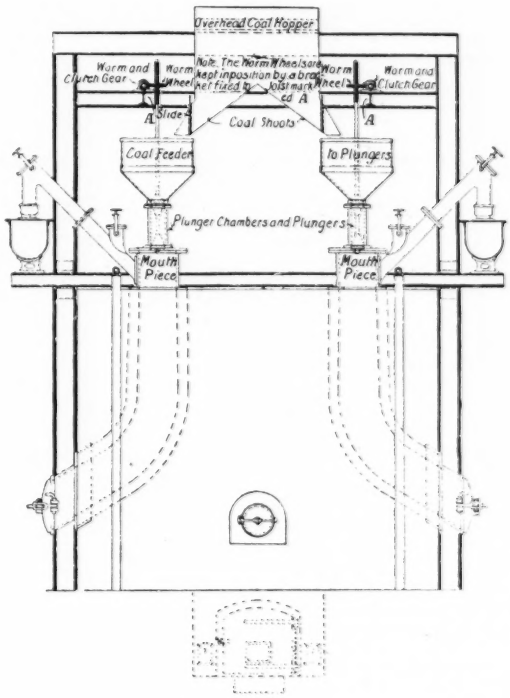
In last week's "Journal," p. 807, an illustrated abstract was given of the patent recently secured by Messrs. Settle and Padfield for a carbonizing process concerning which much interest has of late been evinced among gas engineers. An experimental retort, constructed on the lines then shown, has for months been in successful operation at the Exeter Gas-Works; and the results obtained have warranted a more extended trial of the system. At the present time there is under construction at Exeter a bench of vertical retorts, from the plan which we reproduce to-day; and it is to be hoped that the experiences this will afford of the capabilities of the system, will justify further installations being built at Exeter and at other gas-works throughout the kingdom.

Mr. Norton H. Humphrys, F.C.S., has devoted much time and attention to the results attained in the preliminary trials of the system at Exeter; and we can therefore commend to our readers' careful consideration the following account of his views upon the subject.

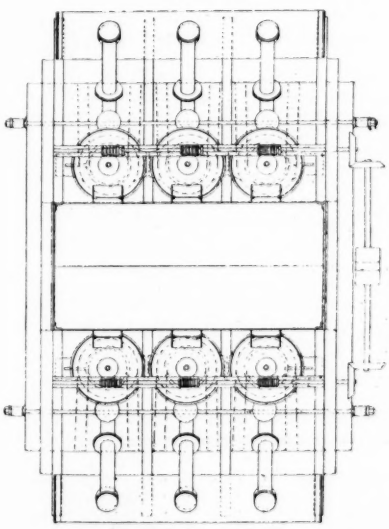
The process described last week (p. 807) as covered by the patent granted to Messrs. Settle and Padfield, of Exeter, has been proved to be capable of yielding, as compared with ordinary methods of carbonizing, a substantially larger yield of gas, a greater sperm value, also an improved yield and a harder quality of coke. The gas and coke are enhanced at the expense of the tar, the yield of which is reduced more than one-half. Further, it is capable of producing these desirable results from small slack coal of a quality that could not be satisfactorily dealt with either



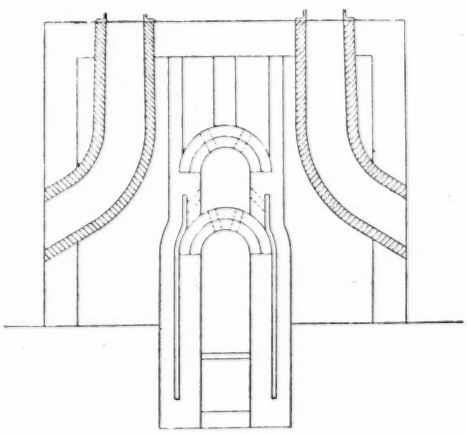
Front Elevation.



End Elevation.



Plan.



Section of Retorts.

in horizontal or inclined retorts. And the working can be regulated and controlled according to the kind of fuel to be used, or the quality of the products desired, to a degree that has hitherto been impracticable.

By the courtesy of the inventors, I have been afforded opportunity for making a personal investigation of the capabilities of the invention; having had the experimental plant placed at my entire disposal and received every possible assistance towards arriving at correct results. It is only right to point out that the figures about to be quoted scarcely do justice to it. Contrary to the very usual experience, they understate rather than overstate the case, because in this instance the experimental retort cannot be worked to such advantage as with a completely arranged set on a larger scale. The retort has been worked in all sorts of ways for several months, and has unmistakably seen its best days. Leaving all this out of the question, and taking the figures as they are, they prove beyond doubt the possibility of obtaining from cheap small coal, quite 12,000 cubic feet of 14-candle gas, and a superior yield of coke. This claim, at the present time, was an extremely interesting one, and my experiments were directed towards the verification of the same—leaving the possibility of making 20-candle gas, and other advantages claimed, for a future occasion.

The description of coal used for the test was Camerton (Somerset) small, obtained by passing some ordinary unscreened from the works' stores over a sieve of ¼-inch mesh. The screenings that passed through were used for the test; and the reason for selecting this coal was simply because out of three or four kinds in stock, it was the one with which I was best acquainted from practical experience. Small stuff of this description could not be dealt with satisfactorily in ordinary retorts, but in order to

get some idea of the quality and capabilities, it was examined in the laboratory, with the following results:—

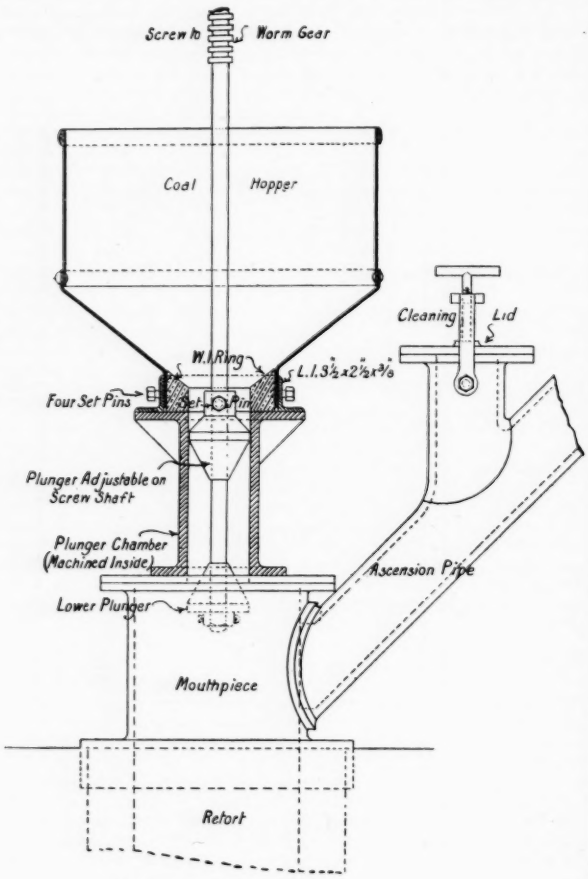
Proximate Analysis.

Volatile at 212° Fahr.	3·8	32·6
,, ,, full red heat	28·8	
Combustible	53·4	67·4
Incombustible	14·0	

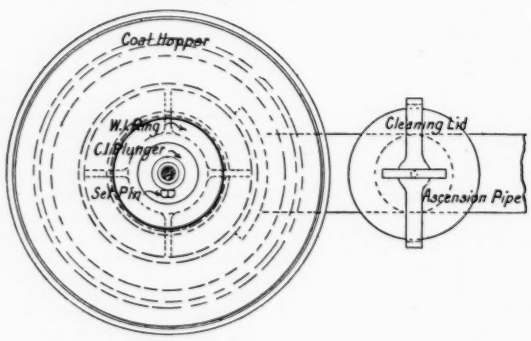
Working Analysis.—Per Ton of 2240 lbs.

Gas, corrected	11·736 cubic feet.
,, quality	11 candles.
Sperm value per ton	443 lbs.
Coke	13 cwt. 84 lbs.

Before proceeding further with the details, it may be well to state some particulars of the apparatus used, and the special



SECTIONAL ELEVATION.



PLAN.

DETAILS OF PLUNGERS, MOUTHPIECES, &c.

eatures of the invention. In practice, the apparatus would be erected in the retort-house, and worked side by side with ordinary retorts, if desired; the gas passing into the common hydraulic or foul main. But for the purpose of investigation and experiment, an independent plant on a working scale has been put down at Exeter. It comprises one full-size retort mounted in a furnace of the regenerative type; a hydraulic seal box; a horizontal condenser consisting of about 100 feet run of ordinary 3-inch cast-iron pipe; a small exhauster, with compensator; a scrubber; a purifying box, 6 feet long by 3 feet wide, charged with one layer of lime 9 inches thick; a wet test-meter, with index graduated to $\frac{1}{10}$th cubic foot; and a 400 cubic feet capacity gasholder. There are the usual arrangements for sampling the gas; and the liquid products are collected in one receptacle, from which they can be drawn off into measures, or into vessels for weighing. Close to the meter is a small cabin, with bench fitted with a Sugg's illuminating power meter, attached by a very short connection to the outlet of the test-meter. There is also accommodation for a set of Bunte's burettes or other gas analysis apparatus. The whole is of ordinary pattern as used in gas-works, with the exception of the retort and arrangements for admitting coal into it, which are the special features and may therefore be described in detail.

The shape of the retort is very similar to that of the knee-outlet used as a discharge at the end of a piece of perpendicular rain-water pipe. It is built of two lengths of ordinary 15-inch round fireclay retort, one end of each piece being cut off on the bevel, so as to admit of the two pieces being joined to form a boot-pattern retort; the leg being perpendicular and the foot inclined downwards at an angle of about 30°. It is a combination of a vertical and an inclined retort, the upright being about 6 feet long and the boot about 3 feet. The upper end shows up flush with the top of the setting; and the bottom, through one side. The lower opening is fitted with an ordinary flange mouthpiece and lid, while the upper end has a special mouthpiece fitted with a gas eduction pipe, and a short double flange pipe 5 inches diameter, with a conical funnel or hopper. A sliding plunger is arranged to travel slowly in the flange pipe, being actuated by a mechanical device comprising a screw, bevel-wheels, and reversing gear. The plunger consists of a rod carrying two cones, pointing towards each other—the lower one fixed, the upper one adjustable. At the top of the stroke, the lower cone rises nearly to the top of the flange pipe; and at the bottom of the stroke it projects some distance into the retort. The funnel being charged with coal, the effect of the up and down motion is to deliver a charge into the retort at each stroke. As the plungers descend, the space between them is filled with coal; and as it nears the bottom of the stroke, this coal falls into the retort—the upper plunger, with the coal above it, forming an efficient gas-tight seal. The distance between the plungers can be so adjusted as to take any quantity from 2 lbs. to 7 lbs. of coal. The lower cone is arranged with a slope of about 60° to the horizontal, so as to avoid simply dropping the charge in one place, and it is sown or scattered evenly over the entire section. All the moving parts are well away from the action of the heat, and the plunger keeps comparatively cool, and quite dry and clean.

It will now be seen where the difference as compared with the ordinary methods comes in. An ordinary horizontal or inclined retort must be discharged or charged at one operation, and that as quickly as possible. But the Settle and Padfield apparatus can be worked as a continuous or as an intermittent charger as may be preferred. The rate of travel of the plunger can be arranged to admit a charge at continuous equal intervals over the whole 24 hours, or the plunger can be stopped at any time. A full charge can be put down in a few minutes, or a sufficient proportion can be let down every hour or two. But continuous working offers so many advantages that it will probably be preferred. There is the same freedom as regards the coke, as any quantity up to half the contents of the retort can be removed without appreciable loss of gas or interference with operations.

As a preliminary, the scales used for weighing the coal and coke were seen to be sensitive and in good condition. They were new and had recently been tested. The accuracy of the test-meter was checked by means of the holder; and the illuminating power meter was compared with a Harcourt pentane standard photometer. The plunger was set to deliver about 6 lbs. at each stroke, and to work at the rate of one double stroke per 100 seconds. The retort was seen to be quite empty.

Coal to the amount of 3 cwt. was weighed out and delivered into the retort as follows:—

To commence	63 lbs.	in 20 minutes
After 1 hour	49 ,,	,, 15 ,,
,, 2 ,,	56 ,,	,, ,,
,, 3 ,,	56 ,,	,, ,,
,, 4 ,,	56 ,,	,, ,,
,, 5 ,,	56 ,,	,, ,,
Total	336 lbs. = 3 cwt.	

The plunger was stopped in each case as soon as the hopper was nearly empty. The coke was removed as follows:—

In 3½ hours after commencement	58 lbs.
,, 5½ ,, ,, ,,	62 ,,
,, 7 ,, ,, ,,	54 ,,
,, 8½ ,, ,, ,, the retort was emptied	67 ,,
Total yield of coke	241 lbs.

The quantity of coke taken out each time was left to the judgment of the man in charge. It was immediately spread on a clean brick-floor, and in half-an-hour was cool enough to weigh. No water was used for quenching. The average temperature at the test meter was 54° Fahr., and the barometer stood at 30·2 in. The test-meter was read every 15 minutes; and an observation on the illuminating power meter was taken immediately after each reading. This method would not give a fair result with the ordinary process, on account of the great variation in quantity made from hour to hour. But with the Settle-Padfield process the yield of gas is fairly regular, and the average of the quarterly

readings throughout closely represents the average quality of the product.

Calculated out to per ton of 2240 lbs., the results obtained are as follows :—

Gas corrected	12060 cubic feet
Average illuminating power	13 candles
Coke	14 cwt. 38 lbs.
Sperm value	535 lbs.

As compared with the laboratory test, the above results show more gas, more coke, and a higher sperm value—

Increased yield of gas	324 cubic feet
,, illuminating power	2 candles
,, weight of coke	66 lbs.
,, sperm value	92 lbs.

These figures are remarkable, but are fully substantiated by a large number of tests upon different kinds of coal, which go to show that, with a sound retort, as much as 13,000 cubic feet of gas per ton of coal may be obtained.

One notable point is that the working temperature need not be so high as that required to ensure satisfactory results in ordinary working. It has long been recognized that the plan of introducing the charge practically instantaneously at one operation, possesses inherent defects, and that the temperature of the retort must be considerably in excess of the average carbonizing temperature attained by the material. At the best, however, the introduction of the cold charge into a hot retort exercises a sort of cold douche or wet-blanket effect, and a considerable period elapses before the charge acquires the average temperature, during which time quantities of tar are produced at the expense of the yield of gas. Towards the close of the charge, things go too far in the opposite direction ; and we have poor gas, deposition of carbon, formation of naphthalene, excessive sulphur, and other troubles. The fluctuation in temperature at each charge, over a considerable range—from a minimum at the introduction of the charge, to a maximum at the time when the spent charge is withdrawn—soon cracks the retorts in all directions; and after a few months working, the deposited carbon is depended upon as a means of keeping them gas-tight. After cleaning, there is considerable loss of gas or risk of over-exhausting.

The Settle and Padfield retort, never being subjected to the 'cold douche" of a full charge, can be worked at a steady, even temperature—not appreciably exceeding that required for carbonization. There is not the variation in quality and rate of yield that are inseparable from the ordinary process; so there is good reason to expect longer life from the retort, less tar, less carbon, and a lower fuel account. Gas as produced in the usual way, consists of a mixture comprising a wide range of qualities and quantities as produced at various temperatures, from an unknown minimum at the beginning up to nearly the full temperature of the setting at the end. And this is the explanation of the known fact that it is possible, when working small charges in an experimental retort, to obtain a higher yield and higher sperm value than is practicable on the working scale, and also how the Settle-Padfield retort goes one better than the laboratory test. When the cold charge is introduced into an ordinary retort, there is a sudden fall of temperature through a considerable range. As carbonization proceeds, the temperature gradually creeps up, at a rate proportioned to the weight of the charge as compared with the extent of heated surface to which it is exposed, or with which it is in contact.

Let us compare an experimental with a 22 inch by 16 inch by 9 feet ⌂ retort, as generally used. The one will be charged with 2·24 lbs., the other with 308 lbs. or 336 lbs. of coal. The small charge, on being introduced into the experimental retort, comes into direct contact with about 100 square inches of red-hot surface; and, in addition, it is exposed to heat radiated from the upper half of the retort, or a total of nearly 100 square inches per pound of coal. A charge of 336 lbs. put into the retort, comes into actual direct contact with about 3400 square inches of heated surface, and receives radiated heat from the upper half, or a somewhat less area. Instead of having 100 square inches per pound of coal, there is something less than 20 square inches. The result is that not only is the fall of temperature less in the first place with the small retort, but the rate of recovery is more rapid, and there is a nearer approximation throughout the first half of the charge, to the proper carbonizing temperature—the temperature that will not make too much tar on the one hand, or a lean non-luminous gas, on the other.

The Settle-Padfield method goes a step beyond the experimental retort. The coal being introduced in small quantities, or pinches, with a marked interval between each stroke, is exposed to a comparatively enormous extent of heated surface. As each charge falls, there is a marked acceleration in the movement of the pointers at the test-meter; showing that the coal rapidly acquires the proper carbonizing temperature. The result is a more regular production both in respect to quantity and quality, in place of a mixture of widely varying quantities and qualities as represented by the fluctuation of temperature above referred to. Consequently, there is a larger yield and a higher sperm value of gas. The tar is certainly reduced to 4 or 5 gallons per ton, and with further experience in working this process there is no reason why it should not fall to a mere nominal amount.

There is no special element of novelty in these considerations. One may say that they have been matters of common knowledge in the profession for half-a-century or more. From the time of Clegg's web retort, to the present, various inventions have been introduced with the object of arriving at the results above indicated. They have not attained a sufficient degree of success to secure their adoption to any important extent; and carbonization of coal, so far as the introduction of the charge is concerned, remains much the same as in the days of Murdoch. It is not that the principle has been proved incorrect, but the cause of failure is to be found in the means of putting it into practice. Mechanical devices for pushing or carrying the charge along the retort quickly become clogged or warped by heat and variations of temperature; while the coke is small, light, and even unsaleable. In the Settle-Padfield apparatus, the coke is not disturbed or broken up; and the mechanical parts are well away from the action of the heat. The plunger remains quite dry and cool, and exhibits no tendency to clog. After being tried for several months, the experimental apparatus is still in working order.

One might enlarge at considerable length on the possibilities opened up by this process. But it will suffice to mention three—the opportunity offered for the utilization of cheap small coal; the attitude of the process towards the question of nuisance; and the quality of coke.

We have lately heard, on unquestionable authority, that coal containing more than a certain proportion of small or dust, is not suited for inclined retorts on account of its tendency to slip. The difficulty of working "small" in horizontal retorts is such that many engineers find it good policy to restrict themselves to screened coal, even if the price is high. But now it is possible to get all the advantages of the high-priced article without the extra cost. Cheap unscreened coal can be passed over a screen on delivery—producing a high-class screened article for the inclined or horizontal retorts ; and the small that passes through the screen can go to the Settle-Padfield retort. Or it affords an opportunity to utilize coal that, though offering the advantage of being cheap, has hitherto been considered as useless for gas-making.

Regarded as a means of preventing nuisance, the process should receive the careful consideration of all who have to make gas in crowded neighbourhoods, surrounded by houses in residential localities, or places where the smoke and fumes are liable to be blown over to adjoining high ground. With every care, it is impossible to avoid a certain amount of soot or smoke, under such circumstances. Even if the works are concealed by trees, or otherwise out of sight, there is the well-known puff of smoke at each charging hour—enabling the neighbours to know for themselves, by unpleasant and unmistakable evidence, when the period comes round. With the Settle-Padfield apparatus, there is absolutely no escape of gas during charging. No one in the next building would know how the charging was done. There is no black smoke or other products of distillation similar to those which escape in the process of charging an ordinary retort. There is nothing except the steam from the extinguished coke, and as the coke is drawn in half charges, with a considerable latitude as regards intervals, and no necessity to draw several charges in immediate succession, the production of steam is so reduced as scarcely to be noticeable on the other side of the works wall.

The quality of coke produced in the test instanced, was harder and denser than that obtained in the usual way. It was well suited (as regards consistency) for cupola use, and would certainly be far superior, for water-gas purposes to ordinary gas coke. If a specially hard coke is an advantage, the working can be arranged to suit.

HIGH-PRESSURE GAS LIGHTING IN LACE FACTORIES.

The Hygienic Aspect of the Question.

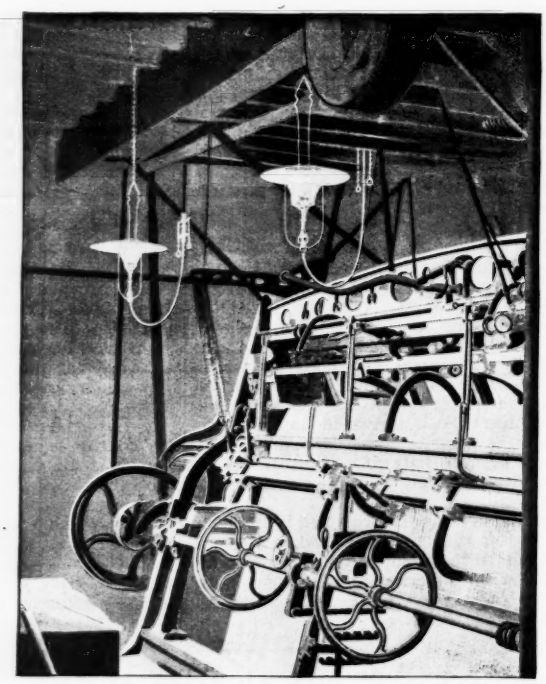
It will doubtless be remembered that in the course of the discussion on the three lighting papers read at the meeting of the Institution of Gas Engineers, Mr. G. Stevenson, of Long Eaton, referred to some trials he had made of high-pressure incandescent gas lighting in certain lace factories in the town (see *ante*, p. 801). Altogether, he has about 400 lights in use, giving a total of nearly 120,000 candles; and he recounted some of the difficulties he had met with in carrying out the installations. One of the most serious of these arose in connection with complaints made of vitiation of the atmosphere ; and, in the end, the whole question was investigated by Mr. W. J. A. Butterfield, M.A., F.I.C., F.C.S. Mr. Stevenson had with him, on the occasion above referred to, a copy of that gentleman's report for the inspection of his colleagues; and he has since forwarded one to us in order that its salient features may become more generally known.

Mr. Butterfield explained at the outset that his investigations were undertaken with the object of determining the relative advantages of different methods of lighting in use in lace factories, and, in particular, the hygienic aspect of high-pressure incandescent gas lighting; and, in order that the bearing of the investigations on the conclusions arrived at might be clearly followed, he thought it advisable to first of all state the principal sources of vitiation of the air in such factories, and to what extent it might be tolerated, having regard to the health of the workers. Taking as conclusive the recommendations contained in the first report of the Departmental Committee appointed by the Home Secretary

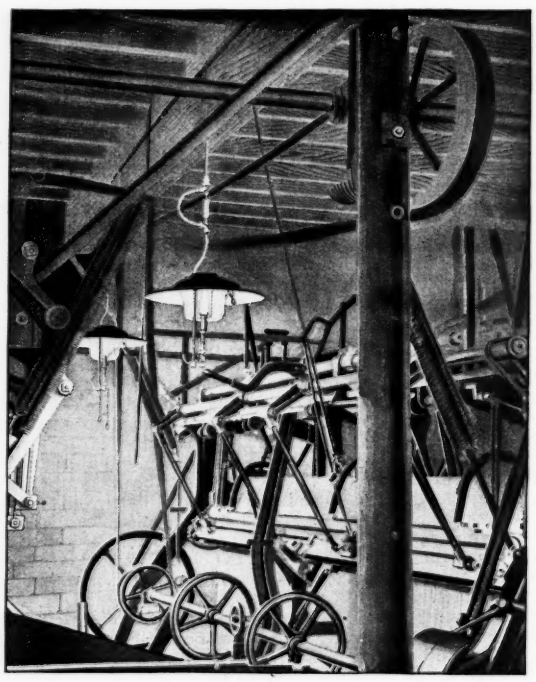
to inquire into the subject of the "Ventilation of Factories and Workshops," which was dealt with in our columns at the time of the issue of that important document,* Mr. Butterfield points out that the Committee consider that the proportion of carbonic acid in the air at about the breathing level in factories and workshops ought not to rise, during daylight, or after dark when only electric light is used, beyond 12 volumes per 10,000 volumes of air, and that when gas or oil is used for lighting, the proportion should not exceed 20 volumes after dark or before the first hour after daylight.

Bearing this recommendation in mind, Mr. Butterfield proceeds to describe the actual conditions prevailing in the lace factories at Long Eaton. They are steam-heated, and work starts ordinarily at 4 a.m., and generally proceeds continuously until midnight, though many machines were stopped shortly after dusk on April 9, when the investigation was made. The factories in many cases are large four-storey blocks, divided into a number of workshops, each occupied by a different tenant. Consequently, various systems of lighting are to be found in different shops in the same building. The workshops have ordinarily on two sides a number of large iron-framed windows, each having one light, about 40 in. by 20 in., which may be opened. The staircase by which the upper floors are reached is commonly built out from the main block and well ventilated; so that it does not appear to constitute a shaft by which vitiated air from the lower workshops passes to the upper. For the proper manipulation of the material in lace making, it is essential that the workshops should have a hot and dry atmosphere; and this condition appears to engender a habit of restricting ventilation as much as possible. As the air space per person in the factories examined was much greater than the legal limit, high proportions of carbonic acid in the air in the daytime would be more than ordinarily significant of bad ventilation.

Mr. Butterfield next proceeds to compare the different workshops, taking first one in which only electric glow lamps were employed for lighting. It was on the second floor of the building, and had a cubic space of about 34,550 cubic feet. There were eight windows and two doors on one side, and ten windows on the other side of the shop. During the daytime, 12 men and 10 women were at work. The cubic space per person was therefore 1570 cubic feet. Three samples of air were taken at the breathing level in different parts of the shop at 4.15 p.m. The results of the analyses of these samples showed that there were, on an average, 8 volumes of carbonic acid present per 10,000 volumes of air. The average of the temperature readings at the same time and place was 74° Fahr. One window light was open. Three samples of air were taken in the same positions at 8.45 p.m., when there were only six men in the shop, corresponding to 5760 cubic feet of space per person. There were 18 large electric glow lamps in use, and a number of the window lights were ajar—having been opened since the afternoon, and not fully closed. The proportion of carbonic acid in the samples averaged 9·5 volumes per 10,000 volumes of air, and the temperature readings averaged 75° Fahr. Mr. Butterfield says it is evident that, having regard to the large cubic space per person, the carbonic acid was in high proportion in the air of this workshop; and as



Sugg's Burners.



Keith's Burners.

High-Pressure Incandescent Gas Lighting for Lace Factories.

it was derived solely from breathing, it indicated slow renewal of the air. The air of the shop was completely changed about once in an hour during the daytime, and the ventilation per hour was about 1620 cubic feet per person.

Before dealing with the shops lighted by gas, Mr. Butterfield offers some general observations on the subject of the production of carbonic acid. The amount given off by people during activity averages about 1 cubic foot per person per hour, and the consumption of oxygen is about 1·1 cubic feet. A cubic foot of the gas supplied by the Long Eaton Gas Company at the time of the tests was found to produce on combustion 0·59 cubic foot of carbonic acid and 1·28 cubic feet of aqueous vapour, while it consumed 1·21 cubic feet of oxygen. Examination of the products of combustion from the high-pressure gas-burners in use in the factories definitely established the fact that carbonic oxide—the chief and most deleterious product of the imperfect combustion of gas—was not present in greater proportion than 1 volume to 20 volumes of carbonic acid; while it was not actually proved that there was any carbonic acid whatever. Carbonic oxide does not exercise any injurious effect on human beings unless it is present in greater proportion than 1 volume in 10,000 volumes of air. So large a quantity was not found to be produced by high-pressure gas-burners in any of the factories investigated at Long Eaton—in fact, the air of two workshops was directly examined for this impurity with negative results. Mr. Butterfield accordingly concludes that "it must be accepted that high-pressure burners, as well as the more usual types of gas-burners, afford perfect combustion of the gas, and do not produce carbonic oxide at all, or, if at all, in quite negligible quantity." He goes on to show, as the result of his investigations, that there will be much less vitiation of the air of a workshop from the products of the combustion of gas when high-pressure burners are used in place of flat-flame burners, even assuming that as many of the former are required. We will leave this portion of the report with the following extract:—

> Each high-pressure burner produces about as much carbonic acid as five persons. Consequently, where, as in the lace factories, there are as many burners as workers (or even more), the effect of the lighting up of the burners on the proportion of carbonic acid in the air will be relatively very marked. Hence, wherever the ventilation of such factories is so bad that the standard limit of 12 volumes of carbonic acid in the air is nearly reached in the daytime, evidently the standard limit of 20 volumes must be surpassed after lighting up, because the ratio of these limits is based on the more usual conditions which prevail in factories, where in general the number of workers exceeds the number of gas-burners required. The number of high-pressure gas-burners installed in a typical lace factory would amply suffice to give light for any ordinary work to be performed by as many hands as could be accommodated in the factory on the basis of 250 cubic feet (the legal minimum) of air space per person; yet if anything approaching this

* See "Journal," Vol. LXXX., pp. 1266, 1398, 1682.

number of hands were employed, the air would become unbearably vitiated in the daytime, unless far better ventilation were provided. Only one of the six workshops investigated at Long Eaton had adequate means of proper ventilation in use. There was a fairly strong breeze on the day when the investigation was made, and the renewal of the air in the workshops would have been much less rapid on a perfectly still day. The proportion of carbonic acid in the air of the workshops (one excepted) was only kept during the daytime a little below the daytime limit owing to the very large cubic space per person and the action of the breeze; consequently the permissible limit would be at once overstepped if a few more persons were employed, if a few gas-burners were lighted, or if the day were quite calm. The want of a proper ventilation, which the investigation reveals, must be regarded as highly deleterious from the hygienic standpoint, irrespective of any consideration of the means of lighting.

Mr. Butterfield next proceeds to give the results of analyses of samples of air taken in two workshops (B and C) lighted by means of large flat-flame gas-burners, and in three (D, E, and F) lighted by high-pressure incandescent gas-burners; the samples in all cases being taken, and the temperature readings made, at the breathing level. (The gas was lighted in all the shops between 6 and 6.15 p.m.) With regard to the two shops lighted on the first-named system, he says:—

Workshop B was on the second floor of the building, and had a space of about 24,200 cubic feet. There were six windows on each side, and one door. During the daytime, five men and five lads and women were at work. The space per person was therefore 2420 cubic feet. Two samples of air were taken in different parts of the shop about 5.15 p.m.—*i.e.*, before gas was lighted; and analyses of them showed that there were, on an average, 8·4 volumes of carbonic acid per 10,000 volumes of air. The average of the temperature readings was 70° Fahr. One window light was open. After 7 p.m. only two men remained. Four flat-flame gas-burners were alight (there had been others also from 6 to 7 p.m.), consuming together 46½ cubic feet of gas per hour. Two samples of air were taken at 8 p.m., and analyses of them showed an average of 16·8 volumes of carbonic acid per 10,000 volumes of air; while the average temperature was 75½° Fahr. The window lights were all closed. The data show that the air of this shop was completely changed, during the daytime, about once in 1·6 hours, and that the ventilation per hour was about 1500 cubic feet per person. Assuming the same rate of ventilation to have been maintained after the gas was lighted, and allocating the air to burners and persons present in proper proportion, the ventilation at 8 p.m. would be about 3600 cubic feet per hour per burner.

Workshop C was on the ground floor of the building, and had a cubic space of about 36,500 cubic feet. There were nine windows on one side, and eight windows and a door on the other. During the daytime, eight men and eleven lads and women were at work. The space per person was therefore 1920 cubic feet. Three samples of air were taken, as before, about 4 p.m.; and analyses of them showed that there were, on an average, 10·9 volumes of carbonic acid per 10,000 volumes of air. The average of the temperature readings was 73° Fahr. After 7 p.m. only three men remained. Six flat-flame gas-burners only were alight after that hour. Two samples of air were taken at 8.35 p.m., and analyses of them showed an average of 11·1 volumes of carbonic acid per 10,000 volumes of air; while the average temperature was 75½° Fahr. The data show that the air of this shop was completely changed, during the daytime, about once in two hours, and that the ventilation per hour was about 960 cubic feet per person. Assuming the same rate of ventilation to have been maintained after the gas was lighted, and allocating the air to burners and persons present in proper proportion, the ventilation at 8.35 p.m. would be about 2930 cubic feet per hour per burner.

Coming to the shops lighted on the high-pressure incandescent system, Mr. Butterfield explains that the burners were placed well above, and slightly in front of, the lace-machines—two to each; and they afforded ample light on the whole of the work. On the other hand, both the flat-flame gas-burners and the electric lamps were moved by the workman to and fro immediately in front of the work; the lights being thus brought constantly close to his face and the work. Two flat-flame gas-burners or three large electric glow lamps, used in this manner, served for each machine. The author points out that the greater convenience of the adequate lighting of the whole of the work from fixed overhead sources of light, such as the high-pressure gas-burners, is obvious; while such lighting is not so injurious to the eyes as any system in which the light source is continually brought into close proximity to them. With these introductory observations, he gives the following results of his investigations in regard to the three remaining shops:—

Workshop D was on the second floor of the building, and had a cubic space of about 34,500 cubic feet. There were ten windows on one side, and nine windows and a door on the other. The total length of the shop was 80 feet; but 16 feet from one end there was a partition, which, however, did not reach within 2 or 3 feet of the ceiling. The shop has therefore been regarded as continuous throughout the total length. During the daytime, eight men and four women were at work. The space per person was consequently about 2880 cubic feet. Two samples of air were taken, as before, about 5.15 p.m.; and analyses of them showed that there were, on an average, 7·6 volumes of carbonic acid per 10,000 volumes of air. The average temperature was 72½° Fahr. One window light and 13 small ventilating flaps were open. After 7 p.m. only five men remained. Twelve high-pressure gas-burners, consuming together 109 cubic feet of gas per hour, were alight. Two samples of air were taken at 7.40 p.m., and analyses of them showed an average of 25·2 volumes of carbonic acid per 10,000 volumes of air; while the average temperature was 74½° Fahr. All the window lights and nearly all the small ventilating flaps were closed. The data show that the air of this shop was completely changed, during the daytime, about once in 1¾ hours, and that the ventilation per hour was about 1900 cubic feet per person. Clearly, the same rate of ventilation did not prevail during the evening, as the window light and some ventilating flaps had then been closed. On the basis of the daytime rate, the ventilation at 7.40 p.m. would be about 1820 cubic feet per hour per burner (which is obviously incorrect).

Workshop E was on the ground floor of the building, and had a cubic space of about 56,000 cubic feet. There were 13 windows on one side, and 12 windows and a door on the other. The window lights were closed. During the daytime, 12 men and 4 women were at work. The space per person was therefore about 3500 cubic feet. Three samples of air were taken, as before, about 5 p.m.; and analyses of them showed that there were, on an average, 10·2 volumes of carbonic acid per 10,000 volumes of air. The average temperature was 67° Fahr. After 7 p.m. only seven men remained. Fourteen high-pressure gas-burners were alight, consuming together 109 cubic feet of gas per hour. There had, however, also been five flat-flame gas-burners in use from 6.15 p.m. to 7 p.m. Samples of air taken at 7.15 p.m. showed an average of 20·3 volumes of carbonic acid per 10,000 volumes of air. The average temperature was 69° Fahr. The data show that the air of this shop was completely changed, during the daytime, once in about 2¾ hours, and that the ventilation per hour was about 1255 cubic feet per person. Assuming the same rate of ventilation to have been maintained after the gas was lighted, ignoring the effect of the flat-flame burners extinguished at 7 p.m., and allocating the air to burners and persons present in the proper proportion, the ventilation at 7.15 p.m. would be about 1340 cubic feet per hour per burner. Having regard to the slow rate of change of the air in this shop, it is clear that a large proportion of the carbonic acid found in the air at 7.15 p.m. must have arisen from the flat-flame burners extinguished only 15 minutes previously.

Workshop F was a single-storey workshop, having 15 windows and two doors, overhead lights, and 15 roof ventilators. It had a space of about 90,000 cubic feet. A 20-horse power gas-engine was in operation in an annexe, communicating with one end of the shop by two doors. Nine men and six women were at work, so that the cubic space per person was about 6000 cubic feet. Three samples of air were taken, as before, at 4.30 p.m., and a further three shortly before 7 p.m., when work was to cease for the day. At 4.30 p.m., the carbonic acid per 10,000 volumes of air averaged 7·6 volumes, and about 7 p.m., 9 volumes. Thirteen high-pressure and two flat-flame gas-burners had been lighted about 6.15 p.m. The data show that, if there were no carbonic acid from the gas-engine, the air of this shop was completely changed, in the daytime, about once in 3·3 hours, and that the ventilation per hour was about 1800 cubic feet per person. Assuming the same rate of ventilation to have been maintained after the gas was lighted, and allocating the air to burners and persons present in the proper proportion, the ventilation at 7 p.m. would be about 1630 cubic feet per hour per gas-burner. There is no doubt, however, that the presence of the gas-engine entirely vitiates these deductions as to the rate of ventilation in this shop.

The following tabular statement contains the more significant figures arrived at in the investigation; those of doubtful value being indicated by a query mark:—

Work-shop.	Method of Lighting.	Daytime.		Evening.	
		Ventilation per Person. Cubic Feet of Air per Hour.	Volumes of Carbonic Acid in 10,000 Volumes of the Air.	Ventilation per Burner. Cubic Feet of Air per Hour.	Volumes of Carbonic Acid in 10,000 Volumes of the Air.
A	Electric glow lamps.	1620	8·0	—	9·5
B	Flat-flame gas-burners.	1500	8·4	3600	16·8
C	,, ,, ,,	960	10·9	2930	11·1
D	High-press're gas-lights	1900	7·6	1820 (?)	25·2
E	,, ,, ,,	1255	10·2	1340	20·3 (?)
F	,, ,, ,,	1800 (?)	7·6	1630 (?)	9·0

Note.—All the buildings are four-storey except that containing the shop F, which is of one storey. Shops C and E are on the ground floor; shops A, B, and D, on the second floor.

The conclusions at which Mr. Butterfield has arrived from his investigation are that electric lighting has no hygienic advantage over high-pressure gas lighting in lace factories, if such means of ventilation as may reasonably be required in all cases are provided. It thus becomes merely a question of convenience, efficiency, and cost, which of the two systems of lighting is to be preferred. He adds that the high-pressure gas system lends itself readily to the improvement of the ventilation of the shops without introducing perceptible draughts.

A Deep Artesian Well.—The artesian well which has been for some time in progress for the supply of the little town of Cadillac-sur-Garonne, in the department of the Gironde, is now finished. The borer struck water at a depth of 660 feet, and the yield is about 1320 gallons per minute. The jet of water rises 48 feet above the ground. The borer passed successively through alluvia, clay, and limestone, and reached water in fine sand of the middle eocene formation. The rising pipes have been cemented so as to collect all the water in a new type of turbine driven by the ascensional power of the well. The town will thus be supplied with water without having to bear the expense of pumping.

INTERNATIONAL PHOTOMETRY COMMITTEE AT ZURICH.

FROM OUR SPECIAL CORRESPONDENT.

This Committee, which it will be remembered was originally nominated by the International Gas Congress at Paris in 1900, had arranged, as already announced in the "JOURNAL" (*ante*, p. 357), to sit this year at Zürich from the 19th to the 22nd inst. Since its nomination in 1900, when eighteen delegates were elected, representing nine countries, the scope of its enquiries has been considerably enlarged. It may be said briefly that the Committee has every claim to be considered truly international; for the only country to the fore in the gas industry which was not represented at the first day's proceedings of this year's sittings was the United States of America, from which the appointed delegate—Dr. E. G. Love—had pleaded inability to attend this year. The names of those present at the first sitting of the Committee on the afternoon of Friday last in one of the lecture-rooms of the Zürich Polytechnic will at once indicate its international character.

The chair was taken by the President of the Committee, M. Th. Vautier, of Lyons, who was likewise President of the 1900 Congress at which the Committee took its inception. He was supported on Friday by four out of the five Vice-Presidents of the Committee: Dr. H. Bunte, Professor at the Technical College at Carlsruhe; M. Ph. Delahaye, the Editor of the "Journal des Usines à Gaz," of Paris, and General Secretary to the Committee; Professor Vivian B. Lewes, of the Royal Naval College, Greenwich; and Herr A. Weiss, of Zürich. Other members of the Committee, or representatives of members, present were: Signor Böhm, of Turin; Herr E. Brodhun, of Charlottenburg; Herr Drehschmidt, of Berlin; Mr. J. W. Helps, of Croydon; Dr. H. Krüss, of Hamburg; Herr H. Nachtsheim, of Vienna; Heer van Rossum du Chattel, of Amsterdam; and M. Sainte-Claire Deville, of Paris. The absentees included the remaining Vice-President, Dr. Love, of New York; Messrs. Charles Carpenter, of London; T. O. Paterson, of Birkenhead; Herr W. von Oechelhaeuser, of Dessau; M. Verstraeten, of Brussels; and M. Lauriol, of Paris. Mr. Carpenter is co-author with Mr. Helps of a paper which is to be read and discussed at one of the sittings of the Committee, and was at the time this report left expected to arrive in Zürich before the last day of the proceedings.

After thanking the authorities of the Federal Polytechnic—especially the Director, Dr. Gnehm, and Professor G. Lunge, who was present—for the accommodation afforded the Committee, the Chairman called upon M. Sainte-Claire Deville for his paper on "The Variations of the Lighting Power in the Incandescent Burner of Combustible Gases regarded as a Function of their Calorific Power." It will be remembered that the distinguished author is Engineer of the Experimental Works of the Paris Gas Company. His communication, extending to nearly 100 pages of printed matter, will be dealt with more fully in an early number of the "JOURNAL;" and for the present it must suffice to follow the summary of its more important points, which he delivered to the meeting with but few references to the actual text of his communication.

The question of the illuminating power developed by incandescent burners must, he said, be looked at from two entirely different points of view: (1) Given a mantle of definite composition and dimensions, how does its lighting power vary when gases of different compositions are burnt under it? (2) Given a particular unvarying gas, how does the lighting power vary when it is burnt under mantles differing in mode of manufacture or in composition? That is to say, the study of the photometry of incandescent lighting entails a distinction being drawn between the photometry of the gas and the photometry of the mantle.

It is well known that the illuminating power of ordinary gas-flames is not a regular function either of the specific gravity or the calorific power of the gas; and empirical methods, based on certain definite conventions, have been adopted for the determination of this illuminating power, which arises from the carbonaceous particles suspended in the flame. But the conditions are totally altered when the incandescent mantle is employed. Every gas which yields heat on its combustion, can likewise yield light. Further, it seems fair to assume that for a given quantity of heat expended in a given time under a particular mantle, the same quantity of light will be obtained whatever may be the composition of the gas used. Thus the value of different gases per unit volume would vary inversely with the volume required to yield a given amount of heat; in other words, it would be proportional to the heat of combustion of a cubic foot of the gas. But there is one serious objection to this theory—viz., that the brilliancy of a mantle depends primarily upon the temperature of the flame by which it is heated. Some gases yield a hotter flame than others, even when the heat expended remains the same. The question is, Does this peculiarity play an important part in practice, and is it a question which only experience can answer? The author has worked with the object of solving it at intervals since the beginning of 1898. His studies have led him to the conclusion that the theoretical temperature obtainable by the combustion of a gas is a negligible factor in all ordinary cases, and that consequently the heat of combustion remains the principal and essential criterion of the value of any gas so far as its use for incandescent lighting is concerned. The author, therefore, thinks that there is no occasion to agree upon international rules for the photometry of the gas in incandescent lighting. On the other hand, the photometry of mantles will only be practically serviceable in the future when it is carried out according to uniform rules, which will ensure results comparable with one another being obtained in different countries.

The paper embodies three sections, of which the first reproduces, with small verbal changes, an unpublished account, from the records of the experimental gas-works at Paris, dated March 25, 1901, of a "Study on the Intensive Combustion in the Welsbach Burner of Coal Gas of Widely Different Qualities." The second is similarly a reproduction of an unpublished record on "The Measurement of the Illuminating Power of Gas in Incandescent Lighting, and a Definition of a Rational Mode of Photometry therefor" (dated June 22, 1901). The third section presents a summary—specially prepared for the meeting of the Committee—of (*a*) some observations made in and after the second week of 1901 to supplement those quoted in the second memoir; (*b*) the two memoirs which constitute the first and second sections; and (*c*) a dissertation on the same questions, dated Dec. 18, 1894, and of too great length for reproduction in its entirety. Finally, the whole matter is discussed, and the conclusions as to the determination of the illuminating power of the gas in incandescent lighting, and that of the mantles, are stated.

In the course of an animated discussion on this most exhaustive communication of M. Sainte-Claire Deville, Professor Bunte expressed the view that the determination of the heat of combustion of a gas could never entirely replace photometric determinations. Professor Lunge, who attended the sitting and did yeoman service as an interpreter, pointed out that some observations by Professor Bunte some four years ago (to which reference had been made) were in reality carried out under totally different conditions to those of M. Sainte-Claire Deville; the one series of observations serving to establish differences in the burners, the other differences in the mantles. The President pointed out that the burners undoubtedly had a preponderating influence on the results; and he then moved that it be resolved by the Committee that, as the heating effect of a gas on the incandescent mantle is influenced by its calorific power, it be an instruction to photometrists to note the calorific power of the gas as well as the illuminating result obtained, and to put on record the results. In the discussion which took place on this resolution, Professor Lewes said that he believed that if experiments were multiplied to a sufficient extent, it would be found that the calorific power of the gas bore no relation to the light obtained from it when burnt under a mantle. For instance, he had found that while London coal gas, which had a calorific power of 630 B.T.U. per cubic foot, gave a light of 80 candles when burnt at the rate of 4 cubic feet per hour in a Welsbach "C" burner, simple (blue) water gas when burnt in an argand type of burner, fitted with a mantle, at the rate of 8 cubic feet per hour, gave a light of 150 candles. The calorific power of the water gas did not exceed 320 B.T.U. per cubic foot; yet an illuminating duty with the mantle of 19 candles per cubic foot (practically the same as that of the coal gas) could be realized with it. But double the quantity of water gas had to be burnt to give a flame which filled the mantle, which was intended for the coal-gas flame. This, indeed, was a fact strongly supporting the line of argument pursued by M. Sainte-Claire Deville; but nevertheless he (Professor Lewes) thought it was necessary in explaining these illuminating effects to fall back upon Professor Bunte's elegant theory of secondary combustion, due to catalytic action on the surface of the mantle. Further, he considered that Mr. A. C. Swinton's work on the light afforded by measured portions of mantles, impregnated with different earths, &c., when heated *in vacuo* by cathode rays, should not be overlooked, as it showed that when the phenomena of flame were absent, the Welsbach mixture of earths afforded no more light than pure thoria or pure ceria similarly made up into a mantle. Also, Professor Smithell's flame separator could be used to show that neither the inner cone nor the outer envelope of a bunsen flame would alone suffice to cause a Welsbach mantle to emit its intense luminosity. Further, when mantles were burnt off by Buhlmann's automatic apparatus, it was only when they had shrunk to the zone of the outer products of combustion that a brilliant light was obtained. Thus he (Professor Lewes) was of opinion that neither heat alone, nor even catalytic action alone, could explain the illuminating effect of a mantle, and that the two together were at least necessary. Consequently, he did not think that the illuminating value of a gas when burnt under a mantle could be measured by its calorific power.

Much discussion on these remarks followed, in which the President, M. Sainte-Claire Deville, Herr van Rossum du Chattel, Signor Böhm, and Professor Bunte joined.

Then M. Sainte-Claire Deville passed on, at the request of the President, to describe a method which he had devised for the examination of the tissues composing mantles. In order to determine the intrinsic value of the mantle tissue, apart from questions of the shape, &c., of the mantle, which affected the light when it was used as a whole in the ordinary way, he took a disc of sheet asbestos having in it four circular holes of equal area and equidistant from the centre, and fixed over two of these portions of tissue from the mantle fabric to be examined. Over the other two holes he fixed similar portions from a mantle fabric

of standard composition—say, impregnated with "pure" thoria. He then directed a blow-pipe flame on to one portion until the position which afforded maximum illumination was ascertained by observation, and the intensity was measured. He then rotated the disc, which was mounted on an axis, until a second circle on it came in front of the blow-pipe flame, when the light afforded was measured. The same process was followed with the remaining circles. Thus a comparison was obtained, under precisely similar conditions, of the light afforded by the one mantle fabric with that of the standard mantle fabric. It was also possible with an apparatus which the President had devised to test the resistance of the mantle fabric to rupture; and, thirdly, it was essential to ascertain the durability of the mantle fabric in respect of constancy of illuminating value.

A discussion followed, in which the President, Professor Lewes, and Professor Bunte joined.

The sitting concluded for the day with an invitation—conveyed through Herr Weiss, the Manager of the Zurich Gas-Works—to the Committee to accept the hospitality of the Mayor and Corporation of Zurich at lunch on the morrow.

ELECTRIC LIGHTING MEMORANDA.

Local Authorities and House-Wiring—Alternative to the Bermondsey Clause—Lighting and Traction Combinations—Bristol Electric Light Finance.

THE Local Government Board and the Board of Trade have agreed as to the law applying to the distribution of electricity by local authorities. As the result of the conference of the Departments on this point, it is announced that undertakers of electricity supply under Provisional Orders will be required to provide connections only up to the consumers' terminals, including the supply of meters if wanted; but that there is nothing in the terms of the Orders or of the Acts of 1882 and 1888 empowering the undertakers to execute any works on consumers' premises beyond the terminals thus defined. This decision settles a matter that was not without some uncertainty, arising as a question of interpretation. The practical result is, that the Local Government Board will not entertain applications by local authorities for sanction to loans for the execution of house-wiring, including the provision of motors or any other apparatus for the utilization of the supply. An incidental effect of the decision will be that users of electricity will fare better in the matter of house-wiring and hiring motors from electricity supply companies than from local authorities, with the few exceptions of those who possess statutory sanction for the expenditure of capital in this way. It may, perhaps, lead to some municipal agitation for an alteration in the law; but a very strong case would have to be made out for any general extension of permission to local authorities to spend public money for such a purpose, because not only would the money so laid out be beyond recall or control, but the arrangement would open the door to malpractices.

The policy of the Bermondsey clause continues to exercise the minds of those who are desirous of encouraging municipal experiments in electricity supply. It has come to be understood that the Board of Trade will not insert the clause in Provisional Orders at the instigation of opponents; but will rather refuse the Order altogether if there is reason to suppose that the demand will be carried to Parliament. On the other hand, it is contended that the condition embodied in the clause is unfair to promoters of Orders, seeing that it does not allow any time at all for working up a remunerative business. The argument is, that if the price of electricity is to be fixed at a paying figure from the start, this must necessarily be so high that it will deter customers from coming forward; thus defeating its own object. This plea might be admissible, if it could be shown convincingly that an electricity-supply undertaking might be depended upon to pay after a reasonable period of grace; but that is precisely what cannot be proved by evidence. The proper alternative course to be taken in the circumstances would appear to be that of allowing any deficit on revenue account to be paid out of capital for a limited term; but this arrangement, though the example was set by Ramsgate, has not been copied generally.

An interesting generalization of electricity supply experience was given in a recent issue of the "Electrician." It was there stated, as an accepted rule, that while the addition of a tramway load to the lighting load of an electricity works is most desirable, and tends to economy, a lighting load superposed on the ordinary load of a tramway power-house tends to increase the cost of generation and the difficulties of management. Yet the statement proceeds to the effect that where the lighting and traction systems are owned by the same authority, it is more economical to supply them from one generating works. It is difficult to understand how these conclusions hang together. One would naturally suppose that if, in any circumstances, it is expedient to combine electric lighting and traction, it cannot matter much whether the operation is called putting the lighting upon the traction or the traction upon the lighting. These observations appeared in our contemporary with reference to the example of Glasgow, which has just declined, by a casting vote, to combine the Corporation tramways and electric lighting undertakings. Doubtless the matter will come forward again; and meanwhile it would be instructive if the first of our contemporary's general rules were explained and illustrated by reference to significant instances. On the face of it, the statement is puzzling.

Such an electric light undertaking as that of the Bristol Corporation ought to be a fine example of this kind of business in itself, and also as a branch of municipal enterprise. No objection worthy of an instant's consideration can be taken to the city as an area for the development of an electric lighting business; and the Corporation were early in the field in their desire to monopolize the benefits of such an undertaking in the public interest. The Corporation works started in 1893, so that there has been plenty of time for them to grow out of their early troubles. As a matter of fact, new works have been built and brought into service during the past year. The capital burden is moderate, being after the rate of about £83 per kilowatt capacity, or £418,757 expended. The amount of revenue earned last year was £52,790, of which £7164 was for public lighting. The capital account, we should remark, was overdrawn £34,533 at the close of the year; so the actual sum expended was about £453,000. The revenue from private lighting, meters, motors, &c., on this was about £45,000 for the year; so that the gross earnings, apart from the Corporation subsidy, were as nearly as possible 10 per cent. on the capital that has been sunk in the business. The gross profit ought to have been as much as this. Instead, all working costs had first to come out of it; and these amounted to £18,486. Add to this management and property charges, £7140; and the total costs mount up to £25,626. This leaves £27,165 to pay all capital charges, or about 6 per cent. on the total expenditure. We cannot quite follow the disposal of this balance as it is given in the "Electrician" analysis, from which we quote, which puts the interest payable on loans at only £11,937, or 2·85 per cent. Surely, the capital costs more than this. Then there is the sinking fund. If these two charges together amount to no more than 4½ per cent. on the capital sunk, they will absorb £20,400, leaving a beggarly £6700 to pay for depreciation, and help the reserve fund of a concern with at least £400,000 worth of perishable property. The business is evidently going to the bad at the rate of about £15,000 a year, to put it most favourably. Not that the users of electric light in Bristol are particularly cheaply served. They pay an average of 3¼d. per unit. It ought to be 5d. The efficiency of electric power distribution may be judged from the statement that every unit sold represents a fuel consumption of about 13 lbs. of coal. Not much advance on ordinary power users' methods here. Yet power is offered at about 1¼d. per unit—considerably under works' cost. There is a mystery about this style of doing business which we cannot penetrate.

"Transactions" of the Society of Engineers.—We have received the "Transactions" of this Society fro the past year. The volume contains the Inaugural Address of Mr. Percy Griffith, M.Inst.C.E., F.G.S., and the papers read at the meetings held under his presidency, with reports of the discussions thereon. A feature of the year's work of the Society has always been the vacation visits; and those of last year were full of professional interest. Following the technical matter are the report of the Council, the accounts, &c.; and last of all comes the valuable general index to the "Transactions" from 1857 to the close of 1902. The whole has been produced under the editorship of Mr. Perry F. Nursey, the Secretary.

Death of Mr. E. Woods.—The death, on the 14th inst., at the age of 89, of Mr. Edward Woods, a Past-President of the Institute of Civil Engineers, calls for brief notice in these columns from his connection with several foreign gas undertakings; he being Chairman of the Hong Kong and China and Porto Copiapo Gas Companies, as well as of the Colombo Gas and Water Company. The deceased gentleman was a distinguished railway engineer, and when he was little more than 22 years old he was made Chief Engineer of the Liverpool and Manchester Railway. In 1852, however, he left the city on the Mersey and settled in London as a consulting engineer. He was elected a member of the Institution of Civil Engineers in 1846, and was President in 1886. The funeral last Thursday was attended by a large number of his colleagues in the Institution and personal friends.

The Alkali Acts Report.—The annual report of the Chief Inspector under the Alkali, &c., Works Regulation Acts, 1881 and 1892 (Mr. R. Forbes Carpenter), was issued yesterday. It shows that at the close of last year there were 1044 works registered under the Acts, compared with 1036 and 1054 for the two immediately preceding years. In the course of the twelve months, 4946 visits were paid and 5091 tests made in connection with the 1477 separate processes carried on. A specially interesting feature of these annual reports is the table of statistics in connection with the production of sulphate of ammonia in the United Kingdom, which the courtesy of the manufacturers enables the Chief Inspector to compile. We find that last year the total was 229,316 tons, apportioned as follows: Gas-works, 150,055 tons; iron-works, 18,801 tons; shale-works, 36,931 tons; coke-oven works, 15,352 tons; and producer gas and carbonizing works, 8177 tons. The grand totals for 1901 and 1900 were 217,213 tons and 213,726 tons respectively. The number of registered works in Scotland at the close of the year was 203; the quantity of sulphate of ammonia made being 76,283 tons.

TECHNICAL RECORD.

THE ENGINEERING CONFERENCE.

The Association of the Physicist and the Engineer.

Although the Engineering Conference convoked by the Institution of Civil Engineers was not actually inaugurated until Wednesday morning, it was an excellent idea, when so many representatives of all branches of the profession were assembled in London, that the eve of the sittings should possess for them such an attraction as the "James Forrest" Lecture. Thus it came about that the theatre of the premier Institution, on Monday evening last week, had within its walls a large and distinguished company to hear the eleventh discourse delivered under the "James Forrest" lectureship. This, as readers may be reminded, was established in 1891, and is administered by the Council of the Institution. The Council determine the subject, and select the lecturer. The ten lectures which preceded the present one have demonstrated most fully the indebtedness of the engineering profession in the past to the researches and teachings of abstract science; and the stage has now been reached when the Council propose to open new ground. They therefore desired that the present lecture should be devoted to indicating some of the directions in which the further aid of the physicist is more immediately required by the engineer; while they hope that, in future lectures, each branch of inquiry thus pointed out will be dealt with in detail by someone who has made the particular subject his special study. The programme foreshadowed is a most important one, embracing almost boundless possibilities; and therefore it was with great hesitation that Mr. W. H. Maw, M.Inst.C.E., undertook its introduction yesterday week. How superbly he fulfilled his task was attested by the acclamation of the large audience at its conclusion. The title suggested to Mr. Maw for his lecture was: "Unsolved Problems in Engineering;" but he selected the more modest one of

SOME UNSOLVED PROBLEMS IN ENGINEERING.

We cannot follow Mr. Maw through his erudite performance; all that can be done is to point its features. It may be at once agreed that, in a civilized community like ours, no engineering problem is of greater importance than the economical generation and distribution of power. Upon this depends the success of our manufacture, the practical value of our means of transport, and, generally, the satisfaction of our needs. In this country, practically we are dependent for our power-supply upon some form or other of heat-engine. This being so, it behoves us to spare no pains to secure in the heat-engines employed the very highest possible degree of economy. The term "highest economy" is susceptible of more than one interpretation. To the physicist it will mean the most complete utilization of the heat supplied to the engine. To the engine user, on the other hand, it means the engine which will afford the highest return on the money expended on its installation and working. Now it is the duty of the engineer, says Mr. Maw, to secure this latter result by a careful study of the circumstances under which the engine will be employed, and of the money value of the various improvements and refinements by which the economy of the engine, regarded from the physicist's point of view, may be increased. Thus, in some cases, true economy may result from avoiding refinements rather than by adopting them. But to enable him to arrive at a proper judgment on such points, the engineer must be in possession of accurate knowledge as to the heat economies which it is possible to secure by the adoption of certain special designs or systems of working, together with data as to the cost of carrying out such designs or methods in practice. It is, in fact, only when what the lecturer calls the "heat economy values" of improvements are accurately known, that their commercial economy can be properly estimated.

THE STEAM-ENGINE.

It is not many years since the only heat-engines in use on a large scale were steam-engines. But now an important share of work is done by gas and other internal-combustion engines; and each year this share is becoming greater. At present, however, the steam-engine, notwithstanding the growth of its rivals, still enormously outnumbers all other prime-movers. Its condition and development, therefore, obtained first notice by the lecturer. It is beyond doubt that the average efficiency of steam-engines as heat-motors has, during the past ten or fifteen years, increased in a most material degree. But the fact that many of the best results have been attained by diverse methods, clearly shows that we have by no means reached finality; and the question as to how further progress is to be secured is one of the problems to which he directed attention.

Professor Unwin in 1895 pointed out that whereas, on theoretical considerations alone, the use of steam-jackets might always be expected to afford highly beneficial results, yet in practice the economy obtained by steam-jacketing varied greatly, and was in some cases a negligible quantity. The causes for this are, to a great extent, known in general terms; but, coming to the quantitative results, our knowledge is far from being of that exact and definite kind which is of real scientific value. It therefore appears to Mr. Maw that the whole question of steam-jacketing, and particularly the application of such jackets to compound or multiple-expansion engines of modern types and of large power, using steam at high pressures, deserves a much more thorough and systematic investigation than it has hitherto received. The action of steam-jackets is, however, only one of several important problems relating to steam-engine economy at present remaining unsolved. Another is the economic effect of interheaters, through which the steam is passed on its way from one cylinder to another of a compound or triple-expansion engine. The data on which the use of such heaters is founded, however, are far from being of a satisfying character, and they present discrepancies which also require clearing up. The question of the economy or otherwise of interheaters is to some extent mixed up with the practice of superheating; but at the same time, the latter also presents certain problems of its own, which are at present far from being satisfactorily solved. What is really required is accurate information as to the extent to which our most advanced steam-engine practice can—especially in the case of large power units—be improved by the use of superheated steam, and as to the manner in which such improvement can best be realized. Equally desirable also is the thorough investigation of the action of steam—both saturated and superheated—in the various types of turbine motors. In addition, the question of the economy to be secured by employing still higher pressures of steam than are now used, requires investigation. These few points indicate the lines along which Mr. Maw came to the conclusion that the steam-engine still affords ample field for experimental research. It is clear that such research must, to satisfy present requirements, be of a character differing widely from ordinary so-called engine trials, and must be carried out by the aid of appliances quite unknown to early experimenters. The lecturer urged that what is necessary is, that there should be co-operation between the various colleges, and the organization of certain schemes of research on lines which should enable each institution to carry out that part of the work for which its equipment is best adapted. To this, as to all the other points mentioned, he devoted considerable attention.

GAS AND KINDRED ENGINES.

Much that Mr. Maw said about the steam-engine applies also to the various types of internal-combustion engines. Under this head, he proceeded—

It is often said that internal-combustion engines have reached their present state of efficiency almost entirely through the lessons afforded by the more or less crude trials and experiments of their makers and designers, and that they owe comparatively little to the researches of physicists. To a great extent this statement is undoubtedly true; but it is, I think, equally true that there has been reached a stage in the development of such engines at which a really systematic and exhaustive investigation of the conditions under which they work is calculated to afford most valuable aid. As a matter of fact, the thorough investigation of the theory and practical working of internal-combustion engines presents for solution problems at once so numerous and so varied as to tax to the utmost the skill and ingenuity of the experimenter. About six years ago, the Institution of Mechanical Engineers appointed a Gas-Engine Research Committee; and this Committee have already issued two reports,* which, although they can only be regarded as touching the fringe of the subject, afford an excellent idea of the difficulties to be surmounted in carrying out researches of this character. Not only have entirely new experimental appliances to be devised and calibrated—and Professor Burstall has shown the greatest resource and perseverance in meeting these difficulties—but it has been found that many of the physical data, upon which we must depend for drawing our conclusions from observed facts, themselves require important revision. For instance, in the earlier experiments on gas-engines, it was assumed, in calculating the results of the ignition of certain explosive mixtures, that the specific heats of the gases forming the products of the explosion were constant at all temperatures. This assumption, however, is now generally regarded as erroneous; and there appears to be good ground for believing that, with an increase of temperature, there is a very substantial increase in the specific heats of such gases. While, however, the general fact may be regarded as proved, the numerical data necessary to enable that conclusion to be turned to practical account are far from having been fixed with certainty, and further determinations are greatly wanted.

Again, the value of experiments on internal-combustion engines depends in a most important degree upon the accuracy with which variations of temperature can be observed, both in the cylinder before and during explosion, and in the walls of the chamber in which the explosion occurs. Engineers owe a great debt of gratitude to Professor Hugh L. Callendar, for his earnest labours in perfecting devices for securing accurate thermometric observations at high temperatures. But, even with these appliances available, the determination of the temperature of exploded gases is by no means a simple matter. As Professor Callendar has himself pointed out, the temperature assumed by the platinum wire of an electric resistance thermometer exposed to such gases must necessarily be less than that of the gases themselves, partly owing to the time required to communicate the heat from the

*See "JOURNAL," Vol. LXXI., pp. 399, 1008, and Vol. LXXVIII., pp. 1030, 1167.

gases to the wire, and partly owing to the fact that, while it is being heated by conduction, the wire is suffering loss of heat by radiation. In dealing with low temperatures, this latter loss is a comparatively unimportant matter. But it is a loss which appears to increase as the fifth power of the absolute temperature; and in the case of such temperatures as have to be dealt with in internal-combustion engines, it has, therefore, a most material effect. Moreover, the rate at which heat is communicated from the gases to the wire is dependent not only upon the difference of temperature, but also on the pressure, in a way not yet accurately known; and thus the correct determination of the results of explosions in internal-combustion engines means not merely the skilful use of known appliances, but the determination of certain physical constants involving much expenditure of time and labour. I have mentioned these two instances only; but they might be multiplied almost indefinitely, so numerous are the branches of inquiry which the exhaustive investigation of internal-combustion engines opens up. It must be further remembered that such engines include not only gas-engines properly so called, but also the numerous varieties of oil or spirit engines, as well as a few engines in which gases are generated by the combustion of solid matters injected into the cylinders. Then, again, the effect of the injection of water, or water-vapour, into the cylinder in itself offers much scope for investigation, as does also the influence of the quality and quantity of the lubricating oils on the gaseous mixture. There thus arise numerous chemical questions, and other branches of inquiry, differing materially from those with which an engineer has usually to deal, and in the conduct of which the aid of trained physicists will be of the utmost value.

Then, again, apart from the problems presented by internal-combustion engines as now made, there are others which may be expected to arise out of the evolution of new types—including possibly some forms of turbine motors. Internal-combustion engines have already realized very considerable efficiency as heat-motors; but it is well recognized that they are subject to very important losses of heat by radiation, and conduction through the cylinder walls, and by the heat carried off in the exhaust, and efforts are constantly being made to reduce these losses. The governing of internal-combustion engines, and regulating the powers developed by them at various speeds and under varying conditions, are also matters which present many unsolved problems.

The question of securing high efficiency in gas-engines has, during the last two or three years, acquired additional importance from the construction of these engines to develop large powers, and to utilize blast-furnace gases. It has been stated by Messrs. Cochrane, as a result of their experience, that the gases from a blast-furnace making 120 tons of Cleveland iron per day are capable, if utilized in a gas-engine, of developing 4500-horse power continuously. This corresponds to 37½-horse power developed continuously for each ton of iron produced per day. Of course, the value of blast-furnace gases for power purposes will vary with the class of ore smelted and other circumstances. But even if we reduce the power available to 30-horse power per ton of iron made per day, then, with our British output of over 20,000 tons of pig iron per day, we get 600,000-horse power as capable of being generated continuously by the utilization of our blast-furnace gases—these gases thus replacing a consumption of (say) between 4 and 5 million tons of coal per annum. It would, however, be out of place for me, in an address of this kind, to dwell at greater length on this particular matter; but I hope I have said enough to show that even internal-combustion engines alone afford a crop of unsolved problems, sufficient to occupy a large staff of investigators for many years to come.

Constructional Engineering.

On another branch of his subject—viz., that relating to constructional engineering and the materials employed—the lecturer discoursed at great length, pointing out that, in determining the ultimate strength of a structure, or part of an engine or machine, consideration has to be given to the maximum forces which may be brought to bear upon it; the stresses induced by these forces in the various elements of the structure; the physical qualities of the constructive materials used; and the extent to which these qualities, or the powers of resistance of individual parts, may be affected by errors of treatment or defects of workmanship. If all these items were known with strict accuracy, it would then follow that an absolutely reliable structure could be built without any excess of material whatever. Of course, in practice these ideal conditions cannot be arrived at, and, to cover the want of exact knowledge, recourse is had to the so-called "factors of safety," which might be more properly named "factors of ignorance." These facts are obvious; and he only mentioned them to enforce the lesson that the greatest aid which can be rendered to engineering progress is the substitution of exact for inexact knowledge, and this is the end for which we should all strive. It is in connection with matters mentioned here briefly, but dealt with by the lecturer in detail, that the physicist is especially able to afford most valuable aid to the engineer.

Cutting Tools.

The lecturer passed on to deal with another matter of the utmost importance to mechanical engineers at the present time—that is, the action of cutting tools; and here the new classes of "rapid tool steel" came under notice. In these new steels, there is presented a series of materials that promise to revolutionize an important percentage of our machine work. In the facts he laid before his audience in this connection, the necessity for extensive research, conducted in a thoroughly systematic way, is again seen. The interests involved are enormous; and it cannot be doubted that the results attained would not only be of great immediate value to both steel makers and steel users, but would also lead to important advances in the early future.

Listening to the lecturer, there could only be universal affirmation of his declaration "that the unsolved problems awaiting the consideration of the engineer and physicist are legion; while each major problem brings a shoal of minor problems in its train." The subject of the lecture, and the method of treatment, were good and appropriate, because, although engineers generally now fully appreciate the aid which physical science can afford, there has not hitherto been such an intimate association of the two classes of workers as is really desirable.

The President's Inaugural Address.

The conference was opened with due formality on the following morning by the President of the Institution of Civil Engineers (Mr. J. Clarke Hawkshaw, M.A.). The inauguration took place in the lecture room of the Institution of Mechanical Engineers, which was tenanted by the gas engineers the previous week. There was a large attendance. From the President's remarks (which, under the circumstances, were of rather a roving character), it appears that this is the third conference of the kind—the first having been held in 1897; and four years, owing to the Glasgow Congress, have passed since the last one. He made suggestions for enhancing the usefulness of the conferences; and then passed in review the work of the Engineering Standards Committee in the past two years—mentioning that it is being supported actively and financially by the five leading Technical Societies and by the Government, who have made a grant of £3000 towards the expenses. Some idea of the magnitude of the work undertaken may be formed from these figures: There are 23 Committees and Sub-Committees, made up of 296 members, of whom 24 are Government representatives. The importance of the education and training of engineers was touched upon by the President, and the qualifying requirements of the Institution in this regard were noted. He laid down the excellent principle that "the engineer who would reach the highest position in his profession should have a thorough knowledge of organization, of administration, and of finance, besides the necessary knowledge of the branch to which he specially devotes himself." Forestry, sewerage, smoke pollution, and mechanical locomotion were among the President's other topics. He concluded with the hope that the members of the various sections would give and receive during the conference much useful information on the practice, both present and prospective, of engineering.

Electricians and Gas-Engines.

The Conference was divided into seven sections; but Section VI.—Water-Works, Sewerage, and Gas-Works—did not meet until Thursday. But during the meeting of the Machinery Section in the Institution of Mechanical Engineers on Wednesday morning, Mr. H. A. Humphrey read a paper on "Internal Combustion Engines for Driving Dynamos." Some extracts from this and an epitome of the discussion appear on p. 898.

Section VI., in which we are more directly concerned, met in the Council Chamber of the Westminster Guildhall on Thursday morning. The attendants made a fairly respectable number. One of the Honorary Secretaries was Mr. E. H. Stevenson, who for the nonce turned his thoughts from professional engagements, and proved himself a thoroughly sedulous official in his temporary capacity. Before the meeting, he secured a substantial list of speakers for the discussions, so that throughout there was no lagging in the proceedings. Sir Alexander Binnie presided.

Mr. G. T. Beilby read some notes prepared to introduce the discussion on

Smoke Abatement: A Tax on the Domestic Consumption of Smoke-Producing Fuels.

The leading types of bye-product coke-ovens and the various forms of gas-producers have been frequently described and discussed before the engineering and technical societies. The large gas-engine and the economic possibilities of its use with blast-furnace and producer gas have also been very fully brought under the notice of engineers and manufacturers, who are now awaiting with interest the results of large installations which have been started, or are in course of erection. If these installations in any degree justify the estimates and expectations of their performance, and if it is shown that electricity can be produced in bulk at a cost of 0·1d. to 0·2d. per kilowatt-hour, with a capital expenditure for gas-producers, gas-engines, and dynamos of from £16 to £18 per kilowatt, even the least sanguine among us must realize that a new era in fuel-consumption has set in. Not only

are power-gas and the large gas-engine on their trial, but the replacement of coal-firing by gas-firing is in the same position. From results which are in my possession, it seems not improbable that the economical firing of steam-boilers with washed gas will be firmly established during the present year. The use of washed gas in iron and steel making is also receiving the most careful attention; and the results of large installations for this purpose will soon be available. The amount of coal which is involved in these departments of consumption is between 80 million and 100 million tons per annum; and it is estimated that one-third of this may be saved if the new departures are even moderately successful. When it is added that these new developments, without exception, involve the absolutely smokeless consumption of coal, it becomes evident that the time is near when the nation, if it chooses, may abolish industrial smoke.

The problem of domestic smoke is in a less hopeful position. The consumption of coal in domestic fires is about 36 million tons per annum. This huge amount is so completely spread over the whole nation that it may safely be said that there is not one individual in the population of 40 millions who is not directly interested in it. It is this fact which makes the domestic problem in many respects harder to solve than the industrial. To the manufacturer we can hold out as an inducement to make an end of his smoke, the hope of a handsome premium in the shape of savings on his bill for fuel and power; but for the householder, there is no such premium. True, the saving in the cost of cleaning and redecorating the house and the reduction in the laundry bill, would represent no small amount for the average family; but at present the means whereby these desirable savings may be effected are somewhat vague and uncertain, and are supposed to involve a serious initial outlay.

If the direct inducement for the householder to abolish his smoke is insufficient to overcome his inertia and conservatism, it is clear that pressure must in some way be applied from outside. The following are three ways in which this might be done: By a great and permanent rise in the price of coal; by prosecution and fining; and by the imposition of a tax on the burning of smoke-producing fuels. As to the first, there is no likelihood that the price of coal will rise to a point which would compel the householder radically to alter the whole practice of domestic heating; it may therefore be dismissed without consideration. For the second method, that of legal conviction, there is little that is favourable to be said. One effect of the extension of this method from the industrial to the domestic department would be to direct increasing attention to all sorts of patent grates and other nostrums, and to divert it from the broad fundamental proposition—viz., that bituminous coal cannot be uniformly and systematically burned in open fires without smoke. I am well aware that there are good grates as well as bad, and that wonderful efficiency and economy can be secured by the skilful designing and setting of domestic grates; but there are two permanent conditions which make it improbable that any large measure of success will be obtained in this direction. These are the irregularity in the quality of the coal consumed, and the dependence of the performance of any grate on the skill and judgment of the person who fires it. The domestic grate is at the mercy of a larger and more varied selection of incompetent stokers than any other coal-consuming appliance!

We are driven, therefore, to the third means of applying the necessary pressure—viz., the imposition of a tax on the consumption of smoke-producing fuels. I venture to suggest that a chimney tax might be so applied as to stimulate and encourage the widest and most radical improvement in domestic heating. Tax every chimney which is sufficiently wide to vent the products from the burning of raw coal, and leave free all those which are too small to do this. This would at once place a premium on the use of smokeless fuel, as gas and coke can be satisfactorily burnt with very narrow chimneys. The production of these forms of fuel would be enormously stimulated; and the devising of appliances for their combustion would be encouraged. The architect and the engineer would have a new and fruitful field for their ingenuity and skill; and their trained efforts would, in a short time, greatly advance our practical knowledge of the subject.

At present the 9-inch chimney holds absolute sway; and a house built without its full complement of these chimneys is looked on as abnormal, and outside of the ordinary practice of those who buy and sell or who lend money on house property. The builder, therefore, declines to erect houses which are really adapted for smokeless firing by gas or coke, with the result that these fuels have never had a chance of showing at their best. If there is a really serious intention of dealing with the question of domestic smoke, I believe it must be somewhat on the lines indicated

In an appendix, Mr. Beilby estimated that 36 million tons of coal is burned in about 8 million inhabited houses. At the rate of two working chimneys per house, a tax of 1s. per chimney would yield £800,000.

Discussion.

In the discussion, there was really very little that can be presented to readers of the "JOURNAL" as new; and to a large extent speakers dealt with the industrial aspect of the question. Professor Arnold Lupton quite approved of the proposal in the paper as to the encouragement of the use of smokeless fuel—say, coke or gas fires—in the household; but he followed this up by declaring his unwillingness to "introduce carbon monoxide into his own house." His own remedy, so far as domestic smoke was concerned, was that smoke-washing apparatus should be put up at the ends of streets; and the smoke from the houses dealt with there. Mr. R. Forbes Carpenter was of opinion that by taxing chimneys, the author would be putting a tax on ventilation as well. Dr. Devereux did not think the English people were in the mood for extra taxes. He gave a good account of his experience of cooking by gas; but he had often felt the difficulty, in using a gas-cooking stove, of getting hot water through the house. He had overcome this by instituting a small coke-boiler in his kitchen; and the cost worked out to only 18d. a week. Cooking by gas and heating water by coke was the system Mr. W. Foulis mentioned he had had in use in his house for fifteen years past. Sir Charles Cookson told how he had completely suppressed the smoke nuisance so far as his house was concerned by the simplest of methods. Nothing but coke is burned in the rooms; and the fires are ignited by a bunsen gas-burner. Mr. J. F. Simmance pointed out that the smoke nuisance was due to disregard of the proper method of stoking, both at home and in industrial works. In his opinion, the proper place for stoking to be done, and where a householder could have his stoking done without any inconvenience to himself was at the gas-works, where there were skilled stokers employed. As to the question of the supply of hot water, he called attention to the gas hot-water circulating systems, which, if properly installed, were, he said, cheap and highly efficient. Mr. Walter F. Read did not think that the best plan for abating smoke was to tax chimneys. What was wanted was a supply of heating gas at a moderate rate. Mr. E. Benson, of Southport, spoke on the industrial side of the question; and then Mr. Charles Hawksley gave satisfactory testimony as to the use of a dozen gas-fires in his house. In his reply, Mr. Beilby said there was practically unanimity that, if smokeless fuel could be obtained, it was the desirable fuel to have. It was proved by the speakers that both coke and gas could be used with great success. If the nation was raised to the realization of the great mischief done by excessive smoke, then the gas engineer and the ordinary engineer were perfectly capable of supplying the remedies wanted. If, however, the nation was indifferent to the subject, and were unwilling to pay to get rid of the nuisance, then the engineers were perfectly helpless. They were indebted to the Smoke Abatement Society and other kindred institutions, for showing what could be done in the enforcement of the present law, even in its imperfect condition.

COAL-GAS STANDARDS AND LOW-ILLUMINATING POWER GAS.

At the close of the discussion on the above paper, Sir Alexander Binnie vacated the chair, which was taken by Mr. Corbet Woodall. Dr. Samuel Rideal then read a short paper entitled "Coal Gas Standards," but it dealt to a large extent with low illuminating power gas. There was an extensive discussion on this; and the report will be found on p. 893.

The Section on Friday met at the Institution of Mechanical Engineers; the sitting being entirely occupied by water and sewerage subjects. Of the contents of one of the papers—that by Mr. Percy Griffith on "The Raising of Water by Compressed Air"—note will be made next week.

THE CONVERSAZIONE.

On Wednesday evening there was a large and brilliant gathering at the *conversazione*, held at the rooms of the Institution in Great George Street. The visitors were received by the President and Miss Hawkshaw, and the members of the Council, at the entrance to the main library. A large number of paintings and works of art, either the property of the Institution or lent for the occasion, decorated the walls or were displayed in glass cases; while a number of engineering models and scientific apparatus were exhibited in various parts of the building. A small room on the first floor was occupied by a collection of coal gas standards, shown by Mr. W. Sugg and Dr. Rideal, to illustrate the latter's paper on this subject. A bar of burners had upon it argands of 20, 18, 16, 15, and 14 candle power, the "London" argand, the burner used on the illuminating power meter, and the standard burner for testing cannel gas. Other exhibits in this apartment were Professor Harcourt's standard 10-candle pentane lamp, Sugg's 10-candle standard argand burner with metallic screen and side screens, his travelling photometer, a model of a 5, 10, or 20 feet standard gasholder, and a Junkers calorimeter.* In the Council-room, Mr. T. S. Lacey, the Engineer in charge of the St. Pancras station of the Gaslight and Coke Company, showed apparatus for the analysis of gas; and Mr. J. Emerson Dowson had on view a model of the new type of his gas plant. An interesting exhibit in the reading-room was a model (in action), lent by Mr. Killingworth Hedges, of a single-acting 30-horse power pumping-engine made by Messrs. Simpson, and used by the Lambeth Water Company from 1853 to 1883. In the same room, Mr. J. F. Simmance showed a clockwork recording pressure-gauge. In the lecture

* Some particulars of this instrument will be found in another column.—ED. J.G.L.

theatre, Dr. Tempest Anderson exhibited views illustrating the volcanic eruptions in the islands of St. Vincent and Martinique. During the evening, the string band of the Royal Artillery, conducted by Cavaliere L. Zavertal, M.V.O., played in the hall; and a selection of vocal music was sung under the direction of Mr. Robert Hilton. The *conversazione* was repeated on Thursday evening, when the attendance was equally large.

VISITS TO WORKS.

Each day during the sittings, five or six visits to works of engineering interest were undertaken; and in most cases they were well patronized.

AT THE EAST GREENWICH GAS-WORKS.

Some New Plant.

In connection with the Gas, Water, and Sewerage Section, a visit was paid on Thursday afternoon to the East Greenwich Gas-Works of the South Metropolitan Gas Company. Roughly computed, the visitors (who were under the guidance of the Hon. Secretary, Mr. E. H. Stevenson) numbered about 80. Brakes transported them from the Maze Hill Station to the works; and at the entrance near to the large gasholders, they were received by the Chief Engineer (Mr. Charles Carpenter), Mr. A. F. Browne, Mr. J. F. Braidwood, Mr. Austin (one of the Workmen Directors), and a number of the works staff. In the capacity of guides, these gentlemen were courteously informative.

Having assembled inside the works, Mr. Carpenter, addressing the visitors, said he had to explain that Sir George Livesey was unable to be present. His absence was unavoidable; and he regretted exceedingly that he was prevented from personally receiving them. Referring to a neatly prepared printed description and plan of the works with which each visitor was presented, Mr. Carpenter said the special objects of interest on the works were perhaps not very many; but the part of the plant of which they were most proud was the two large gasholders—the one of 8 million and the other of 12 million cubic feet capacity. These represented, so far as they were able to say, the two great steps in the progress of the modern gasholder. The 12 million cubic feet one was the largest at the present time in the world. From the point of view of economical construction, so far as the type of framing was concerned and the principle of flying lifts, he did not think much improvement was possible; but they could still, he believed, go ahead in the matter of capacity. The Resident Engineer (Mr. J. Tysoe), he further mentioned, was absent at the present time; and therefore his colleagues Mr. Browne and Mr. Braidwood would do duty for him.

Before reproducing the official description, a few notes collected during the tour of the works (which commenced with an inspection of the Sturtevant fans referred to in the general description, p. 892) may be found of interest. The notes refer chiefly to new work completed or in hand. The first part of a new section of works is in course of construction at the present time. For the moment, there is no great pressing need for the extension; but the expected requirements of next winter will not permit any delay in construction. The consumption at the present time in the district is keeping almost at a steady level; and this reminds us of a little incident related by Mr. Carpenter. He asked one of the men the other day who is concerned with the outdoor work, how it was the increase in consumption was little or nothing. His reply was: "That is the greatest compliment you can pay us, Sir, because it shows the efforts we have made to promote the incandescent light have met with a great deal of success." And Mr. Carpenter believes that is absolutely the true reason for the smallness of the increase that is being netted at present. Adverting also to what Mr. Carpenter previously said as to the limit of economical construction having been reached in point of design in gasholders, it was learnt that the next holder which the Company will build will probably be of from 15 to 20 million cubic feet capacity—thus equalling, if not exceeding, the one that Mr. Bradley is proposing to put up on Long Island for the Consolidated Gas Company of New York. The South Metropolitan holder will be of similar design to the present large structure; and the whole credit for it, when the time arrives, will have to be given, it is understood, to the designer of the present monster at East Greenwich, who (as most engineers know) is Sir George Livesey.

However, regarding the new works, the first retort-house of the second section has been completed, so far as the external structure goes. It runs parallel with the present block of four large houses forming the first section—a roadway dividing it from them. There is no necessity to describe it, as it is similar to the older buildings, the dimensions of which are given in the official description below. It is the interior of the house that will possess the greatest interest for the professional gas man in the future. The settings that are just being commenced will each *contain twenty retorts, or forty mouthpieces*. The retorts are small in section—13-inch rounds, so that the Company are reverting to the old-fashioned form. These settings have been designed with the view of realizing what Mr. Carpenter calls the "modern necessity of gas-making"—that is, the maximum yield of 14-candle gas per ton of coal. This is the Company's present ideal; but how long they will be content to accept it as such is quite another matter. No arrangements have yet been made as to the method of mechanical charging that will be adopted in the new house; but next winter's work will be performed by hand. The house will be fed with coal from the viaduct railway in the same way as the old houses; the extension, in fact, is now being made. Facing the new house a second engine-house has been erected, of sufficient size to meet the needs of the second section—that is to say, for the retort-houses which, as they are constructed, will be known as Nos. 5, 6, 7, and 8. The first engine and exhauster are now being fixed in the new building.

Then as the visitors went round, they came across a massive set of new purifiers which are being constructed, by Messrs. C. & W. Walker, on concrete supports which form a basement. The set consists of four lime boxes and two catch oxides, about 70 ft. by 30 ft. In these new purifiers the water-lutes have been adhered to. The boxes being of large size and the restrictions as to purity being extremely severe, Mr. Carpenter did not think anything was to be gained by departing from the water-lutes. It may interest readers to know that in each of the four purifiers which form the lime set, two diaphragms are used to divide the box into three; and the inlet-pipe is similarly divided, so as to give a better distribution of gas through the material.

Another new centre of attraction was a plant that has been put down for dealing with the refuse coke and clinkers from the retort-houses. The stuff is elevated by means of a bucket elevator, and is then tipped into a screen where it is first roughly screened; the large coke and the clinkers going forward are separated by hand into two hoppers. The smaller coke passes down a water-slide, through a large volume of flowing water, which is supplied by means of a centrifugal pump. The coke ashes and clinker are carried up in a contrary direction by a slow moving conveyor. By the time the material which rests on each blade of the conveyor has reached the top, the light useful coke has been washed down the slide and the heavy clinker, which remains behind, is shot into another hopper. The light coke which reaches the bottom of the slide is again sorted, and stored in separate hoppers. At present, the material is sorted into clinker, large coke, and two sizes of other coke; but it is proposed to make an extension, as it is thought fit to get a greater number of sizes to meet requirements. This is the first plant of the kind, Mr. Carpenter believes, that has been put down; and it has more than answered expectations. Better testimony there could not be than that the Company are considering the question of extending the system to some of their other works. The Hardy Pick Company, of Sheffield, are the makers.

The above is a brief account of the new works; and it may be supplemented by the general description of the works which was presented to each visitor:—

The site of these works was purchased in 1881-1885 for the purpose of making provision for the rapidly increasing demand for gas in the 50 to 60 square miles which form the Company's area of supply in South London. The land so acquired was about 120 acres in extent. In 1900, parliamentary powers were obtained for a further purchase of about 130 acres. Though this site will not be required immediately for gas-making purposes, it was considered a wise provision, in view of the difficulties in obtaining suitable land which must arise before many years pass.

The first block of four retort-houses—equal to a make of 24 million cubic feet per day—is completed and at work. The houses and coal-stores run in parallel lines to the river frontage. This affords ready and economical means for supplying each section with coal and for the transport of the coke and breeze produced in the process of manufacture. Each retort-house is 485 feet long by 73 feet wide. The capacity of each coal-store is about 6500 tons of coal. Each retort-house contains three benches of fifteen settings of retorts, ten in a setting. The section in general use is Ω-shaped; but the last renewals have been made with retorts of elliptical section, which affords increased facilities in working. In No. 1 retort-house the Foulis-Arrol hydraulic stoking machines are used. In Nos. 2, 3, and 4 retort-houses, West's stoking machines are used, actuated by wire ropes driven by gas-engines.

The coal-jetty is at present L shaped, and provided with four hydraulic cranes for unloading one ship at a time. Arrangements are in progress for converting the jetty into a T, so as to increase the coal unloading facilities. Travelling cranes will be used with Hone's grabs, discharging coal from the ships into continuous overhead hoppers under which the railway waggons will run. The jetty is in communication with the coal-stores by means of an elevated railway. A ship of 1250 tons can at present be discharged in about seven-and-a-half hours.

The hot gas from the retort-houses is condensed in 36-inch spiral pipe-condensers. It then travels through a water-condenser, and when sufficiently cool enters the exhauster-house. In the new section which is now in course of construction, the hot gas will be led directly to the exhausters; the cooling taking place under pressure—an arrangement found advantageous at other works of the Company.

The exhausting plant consists of six engines of the "Farey" type coupled direct to the exhausters. The cylinders are 9 and 14½ inches diameter by 16 inches stroke; the entire weight of the pistons being thrown on the outside guides. The air-pump is driven through a link jointed on the connecting-rod. The exhausters are of the following hourly capacities: One 225,000, ten 140,000, and one 125,000 cubic feet per hour. Engines of similar design are in use for the purposes of driving the tar, liquor, and water-pumps. Hydraulic pumping-engines made by Sir W. G. Armstrong, Whitworth, and Co. are also contained in an extension of the building. Steam is supplied by six boilers 8 feet in diameter and 27 feet in length. The firing of the boilers is by coke breeze.

From the engine-room, the gas passes to the Livesey washers, which are worked in sets of threes. These are supplied with ammoniacal liquor from the hydraulic main and scrubbers. The second or final

scrubber is supplied with fresh water, which is collected and pumped over and over in the first or liquor scrubber.

There are six purifiers in a set—four charged with lime, and two with oxide of iron. The lime-purifiers absorb the carbonic acid, and practically all the sulphuretted hydrogen, the removal of which is completed by the oxide of iron. Each purifier is 70 feet long by 30 feet wide by 5 feet deep. From the last purifier, the gas passes to the station meters, each of which deals with 150,000 cubic feet per hour; a set of two being required for each retort-house. The meter-drums work in concrete tanks sunk in the ground, and so save the expense of a meter-house.

From the station-meters the gas passes to the gasholders, where it is stored. No. 1 gasholder, erected in 1885, is constructed with four lifts, varying from 241 to 252 feet in diameter, and 44 feet deep, and has a capacity of 8 million cubic feet. No. 2 gasholder was built in 1891. As the water in the ground was the cause of adding considerably to the work, it was decided to excavate to a depth of 13 feet only, and to carry the concrete tank 20 feet above the ground level. As the diameter of the larger holder is 300 feet and the depth only 31 ft. 6 in., the holder would be difficult to guide when rising unless special care had been taken in the arrangement of the rollers for the inner lift. There are six lifts, two of which rise above the framing; and it has a capacity of 12 million cubic feet.

The fan and governor house contains the Sturtevant centrifugal fans for handling gas under the increased pressure now required. The two low-pressure fans run at 1350 revolutions per minute, handling upwards of 1¼ million cubic feet per hour. Each fan is driven by a 12-horse power nominal gas-engine, and supplies gas direct to the Woolwich and adjoining districts. The high-pressure fans, which are in duplicate and run at 1900 revolutions per minute, are driven by 20-horse power nominal gas-engines, and pump the surplus gas made at these works to the Old Kent Road holders through about 4 miles of 48-inch main. The use of these Sturtevant fans for handling gas is a two-fold one—it increases the carrying capacity of existing mains, and it also makes the working pressures independent of those thrown by the gasholders, which, in the case of large ones, are insufficient for present-day requirements.

At the new chemical works, plant has been erected for the manufacture of sulphate of ammonia and the necessary sulphuric acid. Two units of acid plant have been erected, and the third is now in course of construction. Nos. 1 and 2 units deal with 9 tons of spent oxide per day. The spent oxide contains from 45 to 50 per cent. of sulphur. Owing to the antiquated restrictions in force in London as regards purification of coal gas, practically the whole of this spent material has to be purchased from different gas-works throughout the country; and the sulphur in the crude gas manufactured at the adjoining works is absorbed by lime, and thereby rendered useless. Four chambers in each set are used; the dimensions being 110 feet long by 20 feet wide by 16½ feet high, or a capacity for each of 36,520 cubic feet. For convenience in working, the Glover tower and the Gay Lussac tower are placed side by side; but their sequence of working is, of course, with the chambers interposed. Each unit makes about 15 tons of 1·600 gravity acid per day. In the sulphate of ammonia plant, one unit is completed, capable of turning out 25 tons per day of sulphate of ammonia from 8-oz. liquor.

The liquor is stored and measured in two rectangular tanks, from which it is pumped to the so-called "heaters and coolers," by which its temperature is increased before entering the first still. All the free ammonia is driven off by means of steam, and the liquor is then passed forward to a second still, where it is similarly treated with the addition of milk of lime. The whole of the ammonia is thus completely driven off; the waste liquor passing on to settling-tanks for the purpose of separating the sludge. The ammonia from both stills passes to the saturator, which is a leaden vessel containing sulphuric acid. The acid and the ammonia combine, forming sulphate of ammonia, which crystallizes out, and is lifted at intervals by a steam-jet and thrown into the basket of the centrifugal machine. It is thus dried, elevated, and stored. The sulphuretted hydrogen and other gases pass on from the saturator to the acid-making plant—increasing thereby the volume of sulphurous acid. The heaters and coolers perform the double duty of cooling, and therefore drying, the waste gases before they enter the acid-making plant; and they also raise in temperature the boiler feed water and ammoniacal liquor, thereby saving fuel. The engine is one 70-horse power, with cylinders 12 inches and 22 inches in diameter by 26 inches stroke. It will drive the pumps and machinery required for the second unit as well as the first.

The kindness of the Company to their visitors did not end with the inspection of the works. A marquee had been erected not far from the chemical works on the river side, and there the large party were the grateful recipients of tea. Before leaving the marquee, they recorded, at the instance of Mr. William King, their indebtedness to Sir George Livesey and his colleagues, and very heartily thanked them, as well as Mr. Carpenter, and all who had assisted in making the visit so enjoyable. Mr. Carpenter acknowledged the well-deserved recognition. With this ended a visit which gave those who had taken part in it subject for much conversation during the homeward journey.

THE STAINES RESERVOIRS.

A goodly number of the members of the conference specially interested in the subjects to engage attention on the second day, decided to forego the pleasure of hearing the President's introductory address on Wednesday morning, in order to pay a visit to the water-works which have been constructed at Staines by the firm of which Sir John Aird, Bart., M.P., is the head, to the designs of Mr. Walter Hunter and Mr. R. E. Middleton, MM.Inst.C.E., as the Joint Engineers of the Staines Reservoirs Committee, representing the New River, West Middlesex, and Grand Junction Water Companies. The circumstances under which the Committee was constituted will be in the recollection of most of our readers. It is only necessary to say that the works, which really form the first instalment of a very comprehensive scheme of reservoirs in the Thames Valley, will furnish to the Metropolis an additional supply of 35 million gallons of water daily (or, on an emergency, with the consent of the Local Government Board, 45 million gallons), one-third of which will go to each of the Companies named, who will be severally responsible for this proportion of the expenses. The present scheme was prepared towards the close of 1895, and its execution was sanctioned by Parliament the following year—an extension being, however, granted by a subsequent Act. It comprises an intake on the Middlesex bank of the Thames, about 300 yards above Bell Weir; a conduit (partly covered) to the pumping-station, situated near the Billet Bridge which carries the London Road over the River Ash; two large reservoirs, having a combined water area of 424 acres at the top water-level, and holding, at this level, 3338 million gallons of water; a conduit, of smaller dimensions than that from the intake, to Hampton; and a distributing reservoir at that place capable of containing 30 million gallons of water. These are the main features, presented in the most concise manner possible, of the works inspected on Wednesday. They were commenced on April 30, 1898, when the Chairman of the Committee—Mr. Edmund Boulnois, M.P.—cut the first turf. A description of the works was given in our columns at the time, and their progress has been noticed on several occasions since. Now that they have been successfully carried out, we hope, by the courtesy of the Engineers, to give in an early issue a few additional particulars, accompanied by views of some of the buildings, and diagrams illustrating the constructional details.

The party, among whom were Sir John Dorrington, Bart. (a member of Lord Llandaff's Commission), and Messrs. Francis and Rutter, the Engineers of the New River and West Middlesex Water Companies, left Waterloo by the 9.35 train, and on reaching Staines found conveyances waiting to take them on their tour of inspection, which was very systematically arranged. From the station they were driven to the intake, where the picturesque buildings containing the machinery for working the sluices, and providing accommodation for the attendants, were inspected. Unfortunately, owing to the recent heavy rains, the river was too high to allow of the visitors examining the semicircular screen that prevents leaves and other solid matters from entering the conduit, the first section of which was seen from the back of the sluice-house. The next move was to the valve-house adjacent to the reservoirs. A descent was made into the depths below, where, by the aid of lights, the course of the great mains from the pumping-station to the two water-towers (one in each reservoir) was observable. Returning to the purer atmosphere, the party ascended the embankment of the upper reservoir, when a lovely sheet of water, sparkling in the bright sunshine, presented itself to view. The top water-level of this reservoir is 39 feet; that of the lower reservoir 29 ft. 6 in. After a glance round the water-towers, the visitors were driven to the pumping-station, where the five double triple-expansion surface-condensing engines, with Worthington pumps, which have been supplied by Messrs. James Simpson and Co., were much admired; considerable interest being shown in the arrangement by which the middle engine can, by means of a breeches pipe, be made to deliver into either of the two pipes which are being fed by its neighbours. Adjoining the engine-room is the boiler-house, fitted with six Babcock and Wilcox boilers, each of 110 nominal horse power. Another house contains the Venturi recording instruments, which will show at a glance the quantities of water pumped into the reservoirs, passing down the conduit, and being taken by the several Companies. In the spacious workshop forming one of this group of buildings luncheon was served—Mr. Hunter occupying the chair—and a few appropriate toasts were cordially honoured.

After luncheon, the conveyances were again requisitioned to take the party to Hampton. A pleasant drive brought them to the pumping-station of the Grand Junction Water Company, of which Mr. Hunter is the Engineering Director, where some more of Messrs. Simpson's machinery was inspected. The proximity of the Riverdale works of the Southwark and Vauxhall Water Company afforded an opportunity for the party to look into the spacious new engine-house, with its fine set of three triple-expansion engines, erected by the North-Eastern Marine Engineering Company to the designs of Mr. J. W. Restler, M.Inst.C.E., which were described and illustrated in the "JOURNAL" about two years ago, on the occasion of the commencement of the Company's new reservoir at Walton. From these works to the White Hart at Hampton, where tea was served, was but a short run; and this really brought to a close a visit which had been full of interest, and had fortunately been favoured with fine weather.

It only remains to say that both Mr. Hunter and Mr. Middleton, as well as Mr. Basil P. Ellis, a member of the Contractors' firm, freely and fully answered all questions put to them in regard to the works which they have so successfully completed; while Mr. George O. H. Klopp, Assoc.M.Inst.C.E., the representative of Kent's Hydraulic Engineering Works, the suppliers of the Venturi apparatus, furnished particulars as to its action.

Twenty-four applications have been received for the vacant position of Gas Manager to the Halifax Corporation. The Gas Committee are considering them.

COAL GAS STANDARDS.

The Question of Low-Power Illuminating Gas.

The second introductory paper read in Section VI. of the Engineering Conference on Thursday morning, was by Dr. SAMUEL RIDEAL, F.I.C. It is entitled "Coal Gas Standards," but, as will be seen, it deals more particularly with the question of low illuminating power gas. During its consideration, Mr. CORBET WOODALL presided.

The CHAIRMAN said, in introducing Dr. Rideal to read his notes on "Coal-Gas Standards," he might remark that the author had chosen a very appropriate subject, having regard to the condition of matters in the gas industry at the present time. The industry was in a very prosperous condition. In the last ten years, there had been an increase of something like 70 per cent. in the quantity of gas sold throughout the kingdom; and between 1897, when he (Mr. Woodall) had the honour of reading a paper in that room on the question of carburetted water gas, to 1901 (the year of the last returns of the Board of Trade), there had been an increase of over 30 per cent. in the quantity of gas made and sold. Yet at the same time, there was a certain feeling that the gas industry was in a state which might be called one of transition. The quantity of gas used for purposes in which illuminating power *per se* was of no particular matter, was rapidly increasing. They had heard a great deal about the use of gas for heating, cooking, and power, and latterly (through the introduction of incandescent mantles) for lighting. The proportion of gas so used was very large indeed; and he should say that fully 60 per cent. of the gas burnt at the present time was for purposes in which illuminating power alone was of no moment. Yet it would be the greatest mistake in the world to suppose that, because illuminating power in itself was not wanted for these purposes, therefore the constituents that made the illuminating power were of little value. According to the present state of their knowledge, it was impossible to reduce the illuminating power of coal gas without at the same time reducing its heating value; and the question which had to be determined was simply whether or not the economy to be effected by reducing the illuminating power was as great as, or greater than, the loss experienced by the consumer in using the inferior gas. But these changes that he referred to did point to the necessity for modifications in the methods of testing; and he hoped they would hear from Dr. Rideal some suggestions as to the direction in which these modifications were likely to be most valuable to the industry.

Dr. RIDEAL then read his notes as follows:—

The economic value of a gas supply depends upon its pressure and its suitability for public or private use. Under a properly adjusted sliding-scale, the interests of the consumer and the producer are identical. In England parliamentary restrictions and the patent monopoly in the case of incandescent mantles have retarded the development which has taken place elsewhere. In London, from 1876 to 1900, the three Companies under the Gas Referees were stereotyped as to pressure, quality, and purity, with the result that the consumer paid 50 per cent. more on the north than on the south of the Thames. This difference is enormous when one considers the cost of the gaseous fuel of a power-station for the electric lighting of the Embankment at the two ends of Hungerford Bridge.

In 1900, the South Metropolitan Gas Company obtained parliamentary sanction to reduce their illuminating power from 16 candles to 14 candles, followed by the Commercial Gas Company in 1902 obtaining a similar reduction on paper, but which in practice results in London at the present time being supplied with gas of three different qualities with regard to luminosity. As the illuminating power, when tested by a given standard argand burner, depends on the ratio of the air supply to the combustibles in the gas, it is obvious that alterations in quality involve the readjustment of this ratio. Standard burners for 14-candle gas have been designed for use outside the Metropolis in some cases; but it seems unwise at the present time to multiply standards indefinitely, especially as during the present session the Crystal Palace Gas Company have made another departure in seeking a further reduction to 13-candle power. Plymouth has likewise obtained a reduction of 1 candle (from 15 to 14) without any lowering of initial price, which means, in other words, that in this case Parliament attached no monetary significance to the illuminating value.

The dearness of cannel and the lack of carrying-power of poor gas enriched with volatile hydrocarbon vapours made it appear obvious that "the game was not worth the candle," and helped to dispel the exaggerated idea of the importance of high candle-power gas. It is probable that these methods of adulteration will soon disappear. The parliamentary return of gas undertakings, issued in August, 1902, shows that at present 55 out of 252 local authorities and 86 out of 487 companies use enrichers mainly for carburetted water gas, employing annually nearly 40 million gallons of benzols and petroleum oils, many of which add considerably to the sulphur impurity. As the illuminating value is a meaningless expression apart from a burner, so also enrichment has no economic advantages when gas is used for power or incandescent lighting. There can be no direct relation between the illumination given by gas in a particular burner and its calorific value; but, in general, it may be said that enrichment for flat-flame burners gives the maximum amount of heat for the least amount of light, so that even at the present time a calorific value assigned to a gas supply would give a more certain figure for fixing its commercial value than the official method.

A lowering in carbon density diminishes the illuminating value to a greater extent than the calorific value. The increase in volume required to ensure an identical amount of heat with a low-grade gas does not consequently involve a greater pollution of the air; and as in all cases flueless heating is to be deprecated, the change to a low-grade heating gas gives no practical disadvantage to the consumer. It is a strange coincidence that in Paris at the present time, after an undisturbed monopoly of fifty years, the gas supply is now under review, and that the advisers of the Municipality there are attaching no importance whatever to the illuminating value, nor to the presence of sulphur compounds, other than sulphuretted hydrogen, in the gas. I think I am right in asserting that any restrictions imposed will be in the direction of limiting the carbon monoxide and in ensuring a minimum calorific value. As a further illustration, the Caterham and District Gas Act, 1902, may be cited, in which the Company are authorized to manufacture and supply gas for light, heat, power, and any purpose for which gas may be applicable within the limits of the Act, and may make a "power gas" capable of being used for purposes of motive power, incandescent lighting, and heating, which need not be of any illuminating quality, but which it is unlawful for the Company at any time to supply with a content of more than 14 per cent. of carbon monoxide, or not possessing a distinctive and readily perceptible smell. The non-removal of sulphuretted hydrogen and sulphur compounds would conduce to this latter requirement.

Out of the 692 undertakings which have been sanctioned since 1860, when the sulphur clauses were introduced, only 51 have any sulphur restrictions, and in 21 no tests are made. There are no instances of sulphur clauses being recently imposed, but several of their being repealed within the last few years—*e.g.*, Birmingham, Barnstable, Hebden Bridge, Loughborough, Todmorden, Walton-on-Thames; and this year the Crystal Palace Gas Company's Bill has passed the Commons Committee.

As lime only arrests 2 or 3 per cent. more of the total sulphur than oxide of iron, the disadvantages and costs attending its use more than outweigh any possible theoretical benefit accruing to the consumer by the retention of this small amount of extra sulphur. In London alone, I calculate that more than a thousand times as much sulphur is contributed to the air by the coal consumed as by the gas supplied, and that the sulphur impurity developed from illuminating petroleum in London at the present time is practically equal to that derived from coal gas. The removal of naphthalene, although not demanded by legislation, seems to have far greater advantage for the consumer, as its absence ensures more constant pressure and quality.

Improvements in utilizing a 10-candle gas under a higher pressure may certainly be looked forward to in the near future, so that, with decrease of illuminating value, increase in pressure may be demanded by the public. A greater rate of flow in gas-tight distributing-mains should effect an economy in cost of distribution, as the necessity for larger mains would be postponed.

Discussion.

The CHAIRMAN said the paper seemed to have gone rather wide of the mark of "coal-gas standards;" but it bristled with points that invited discussion and comment.

Mr. G. C. TREWBY (London) said the author stated that in London from 1876 to 1900, the three Companies under the Gas Referees were stereotyped as to pressure, quality, and purity, with the result that the consumer paid 50 per cent. more on the north than on the south side of the Thames. He could not really understand what the author meant by that, because the Gas Referees, so far as he (Mr. Trewby) knew, had nothing to do with the pressure. That was fixed by Parliament. The quality, too, was fixed by Parliament. Thus the purity was the only point with which the Gas Referees had anything to do. They had instructions to draw up the conditions under which the gas should be tested for purity. As to the gas costing 50 per cent. more on the north than on the south side of the Thames, he had had the actual figures taken out from 1876; and it came to only 18 per cent.—that was an average of 18 per cent. difference between the price of gas on the north and the south sides from 1876 to the present time. So perhaps the author when he replied would explain what he meant. Then Dr. Rideal also said that London was supplied with gas of three different qualities. That, again, he (Mr. Trewby) did not think was quite accurate. The Commercial Gas Company had now got the same testing powers as the South Metropolitan Gas Company. Therefore, there were now only two qualities of gas in London—14 and 16 candle. It appeared to him, however, that the gist of the paper had reference to the lowering of the illuminating power of gas. Now he (Mr. Trewby) did not see what the public were going to gain by the lowering of the illuminating power. He was of opinion, formed from calculation and actual facts that had been brought out, that, provided the price per unit either of candle power or calorific value was the same for the high power gas as for the low, it was very much better for the public to have the higher power gas; and so far as the suppliers were concerned, they saved in the main power. For example suppose a gas had

about 600 British thermal units per foot, if they went down to 500 units, they would have to send one-fifth more gas through the mains to get the same heating power as they had before. They must therefore increase the size of the mains, or work at a much higher pressure. He had no doubt about it, that if they could supply gas of the higher power at the same price per unit of candle power or British thermal unit, that it was the cheaper gas for all purposes. So far as the Company he was connected with were concerned, they found that the difference between 14 and 16 candle power cost them somewhere about 1d. at the present price of petroleum. Therefore, it was far better for the public, as being participators in the sliding-scale, that they should have the benefit of the higher power, because from figures which they had got it was found that, if they reduced the gas from 16 to 14 candles, those who used batswing burners would have to pay 5d. more to get the same illuminating power as at the present time; and those who used it for heating, cooking, power, and for Welsbach burners, would have to use a much larger quantity—more than the nominal reduction of 2d. The companies could not really afford to give the 2d. Inasmuch as it only cost them a 1d., they could not afford to come down 2d. in their price. Therefore it was only a nominal figure after all; and what the public would have to pay would be simply the price at which the companies could afford to supply the gas. Now with reference to what the author said about the increase in the amount of sulphur per 100 cubic feet. He stated that "at present 55 out of 252 local authorities and 86 out of 487 companies use enrichers mainly for carburetted water gas, employing annually nearly 40 million gallons of benzols and petroleum oils, many of which add considerably to the sulphur impurity." He (Mr. Trewby) did not know what was meant by that. It was true there were some of the benzols which were not properly purified, and which were used for enriching purposes. They contained a slight amount of bisulphide of carbon; but they were only used to a limited extent. In the case of his Company, they increased the illuminating power of the gas made from Durham coal by the use of carburetted water gas, and this only contained 3 grains per 100 feet, whereas the gas from coal contained 40 grains, and some of it as much as 60 grains, per 100 cubic feet. Therefore he did not quite understand what the author meant by that. It was altogether contrary to facts and experience. The author also spoke about gas not carrying in its illuminating power. Well, at their large works at Beckton the enrichment was done there by carburetted water gas; and he had a statement for the whole of the last twelve months, during which period they used an average of 19 per cent. of carburetted water gas. The average illuminating power taken month by month for the year was 16·49 candles at the Beckton works. These works were 8 miles from the City, where the gas was officially tested at Tudor Street. The test there was 16·36 candles, and by the public test it was 16·44 candles. Therefore they had gas leaving Beckton at 16·49 candles, and arriving at 16·36 candles. This entirely contradicted what the author said on this point of enrichment, or, as he called it in one place, "adulteration." That the addition of carburetted water gas was of no value so far as the consumers were concerned, he begged to say was entirely opposed to what his Company found in practice. Then with regard to the test-burner, he agreed with Dr. Rideal there, that they found the necessity of having a test-burner that would give the proper and full luminosity to the gas being supplied. They were bound down to the "London" argand burner. It was a good burner when first introduced for 16-candle coal gas; but it was utterly unsuited now for the testing of the mixture of carburetted water gas and coal gas—for the reason that it admitted too much air. If they took the same gas and used it in another burner (he would not mention the name), but a burner which had been certified as a test-burner, they would gain 20 per cent. in illuminating power—that was to say, their 16-candle gas, when tested in the burner he spoke of, would appear as of 19-candle power. Therefore, this showed that the whole subject was in a complete muddle so far as testing was concerned. It was gratifying to know the Board of Trade had made up their minds to appoint a Departmental Committee to go into this very question; and he hoped that, when the Committee had heard the evidence and reported, the matter would be put on a more satisfactory footing than at the present time.

Mr. Charles Hunt (London) said the object of the author appeared to be to draw attention to the desirability or otherwise of removing, in some measure at all events, the restrictions which were at present imposed upon gas undertakings in regard chiefly to illuminating power and the removal of sulphur compounds. He thought the discussion on the previous paper indicated the truth of what Professor Lewes mentioned the other day, that in the use of gas as a fuel there was most chance of it advancing. This being so, the illuminating power should take at all events a second place. If the calorific value of gas went down in proportion to the illuminating power, or if a high illuminating power could be maintained at a proportionately lower cost than a low illuminating power, then there was not much in the argument for reducing the illuminating power. Mr. Trewby said he could maintain a 16-candle gas—that was an increase of 2 candles on the 14 candles—at a cost of 1d.; but he qualified this by saying "at the present price of oil." There they had the whole gist of the question. If oil could remain at the present price, there was not much to be said in favour of reducing the illuminating power. But they had to judge from the past; and, as many present knew, the price of oil had been subject to considerable fluctuations—to such fluctuations that he thought he was right in saying (in fact, he had good grounds for saying) that those who had depended in the past on water gas had not made their gas so cheaply as they might have done if they had depended wholly on coal gas. He might explain briefly how he had arrived at this conclusion. He had examined "Field's Analysis," and taken from it the average cost to the Metropolitan Gas Companies and some of the principal Suburban Companies of the items which were affected by the manufacture of carburetted water gas. They were materials, purifying, wages, and repairs. With regard to the last two items, there were disturbing causes which rendered no dependence upon them possible, and so they were of doubtful value. The cost of wages was influenced by the adoption of machinery or inclined retorts (which had been considerably the case), and the item of repairs was affected by the amount which companies might from time to time expend upon them. Therefore they had to depend chiefly upon the first two items—the cost of material and the cost of purifying; and he found that, in four cases out of five, the cost had been enhanced apparently by the adoption of water gas—in one or two cases, very considerably; indeed, to a greater extent as regards the cost of material than could be recouped by any saving in wages or repairs. Therefore he thought that the first thing to consider, having regard to the extended use of gas for heating purposes, was the bringing down of the cost without, if possible, reducing in greater proportion the calorific value. They knew the calorific value of pure coal gas did not diminish in proportion to its illuminating value—at all events, according to the present methods of testing illuminating value. Therefore, if by any means they could diminish the illuminating power, and at any rate proportionately reduce the cost, it would be an advantage to the consumer. He did not think that the abandonment of enrichment was the only advantage that would accrue from the adoption of a low quality. He was perfectly of opinion that improved carbonizing methods would result in substantially increasing the yield of gas per ton of coal of a low quality. He had been assured only recently that from a class of coal, of which large quantities were used in London at the present time, 12,000 cubic feet per ton of 14-candle gas could be obtained. If this was really so, surely it would be a very considerable advantage to the consumers, and also to the companies, to reduce the illuminating power to at least 14 candles. But he did not think they were destined to stop at 14 candles. With an increased demand for fuel gas, they were bound to gradually reduce the illuminating power—not by leaps and bounds—but gradually, as they found their methods improving in the cost of manufacture; and they might find themselves, before many years were over, supplying the 10-candle gas suggested by Dr. Rideal in his paper, their main source of revenue then being the gas used for heating, cooking, and power purposes. Mr. Trewby suggested that it would be uneconomical to distribute gas of a lower illuminating power. He agreed that there was a difference in the cost of its distribution; the lower they went in value, the greater was the cost. But he thought that everything pointed to the possibility of this being met by increased pressures. Already they had become familiar with distributing gas at higher pressures; and the lower the illuminating power, the less was it likely to suffer from increased pressure. He agreed also with Mr. Trewby as to the testing of gas, and joined with him in expressing satisfaction that the question was likely to be brought to a satisfactory settlement by the proposal of the Board of Trade to appoint a Departmental Committee to decide the whole matter. He (Mr. Hunt) had long advocated the testing of gas not only with the best burner available, but under the best conditions which the burner was capable of affording, and he was glad this principle had gradually gained ground. It had found its way at last into several Acts of Parliament; and it seemed destined to be the recognized method of testing the gas of the future. He did not think it would be desirable to multiply standards. The best method of testing with the so-called standard burner was at a fixed illumination of not less than 16 candles—he would go a little higher, but not less; and the fixed illumination of 16 candles was good for testing gas of a much lower quality. If this standard could be generally adopted, they would have a method of comparing results obtained in almost any part of the kingdom.

Mr. Isaac Carr (Widnes) said he was afraid he could not agree with many of the points advanced by the author in the paper. He, like Mr. Trewby, was entirely unable to account for the difference of 50 per cent. in the cost on the north side and south side of the Thames. Even if they considered the difference in the price alone, in his experience he had known a difference perhaps of 20 or 30 per cent. from time to time; but he believed they might take Mr. Trewby's average figure of 18 per cent. The figure of price, however, was not the only one in this question. They must look at the amount of light in considering the question of price; and if they did this in the case of these two particular Companies, what did they find?—that with the gas supplied by the Gaslight and Coke Company, the consumer could obtain 30 per cent. more light from the best type of flat-flame burner than the consumer on the south side of the river could obtain with the so-called 14-candle gas. Therefore, if they took it on the basis of light, the gas on the north side of the river was at the present moment the cheapest. With regard to the question of standards, it was contended that gas companies were

entitled to all the light that could be got from the burner. Well, he had stated quite recently that, so long as the consumer could participate in any improvement that took place in the burner, this was quite right; but at the present time, and for years past, they had got a fixed idea of standards, and from that fixed idea of standards they could interchange ideas of qualities. But if, by the recent manipulation of burners and chimneys and photometers, the question of quality became the will of the operator, under this or that particular form of test, how were they to know what the quality of gas was, or how were they to get any intelligent interchange of ideas. They simply came to utter chaos. Moreover, it must be borne in mind that the argand burner was not a burner suitable for the consumer. He said, if these conditions of testing with the argand burner were applicable to the man in the street—the man who had to burn the gas—then he had no more to say. These burners had been invented for fifty years; and they were of no more use to-day than they were at the time they were invented. The South Metropolitan Gas Company showed this by giving what they called a special burner suitable for their gas, and that burner was of the flat-flame type, and not of the argand type. With regard to the question of enrichment, the author spoke of dearer cannel. But at the present time the price of cannel was cheaper than it had been for this last two or three decades; and beyond cheaper cannel, they had now the advantages of carburetted water gas, petroleum spirit, and benzol —all of which were easy of application, and, in addition, cheaper than the present reduced price of cannel. So that he (Mr. Carr) held that this was a special point in favour of maintaining a higher quality of gas, that gas authorities in the kingdom to-day had excellent and cheap facilities for maintaining a higher standard for gas, and that there was no excuse for reducing the illuminating power, which meant a tremendous loss to the consumer. The author drew attention to the Act of Parliament obtained by Plymouth, and stated that Parliament allowed a reduction of 1 candle without any reduction in price, and that the probable reason for this was that the reduction from 15 to 14 candles carried with it no monetary significance.

Dr. RIDEAL: In the minds of the Committee.

Mr. CARR said that, of course, if they were going to start and base new theories on the decisions of Parliamentary Committees, most gentlemen would agree that they would get very much astray; but that statement was contrary to all physical and commercial laws, experience, and fact. If one candle had no value, then any number of candles could have no value. He could not understand the author making a statement like that. Now, with regard to his own practice, he happened to be in the position of selling gas at Widnes at prices varying from 1s. 4d. to 1s. per 1000 cubic feet; and while they sold at these abnormally low figures, he considered that, had the low price been maintained by a reduction of the quality to such a degree as the Crystal Palace District Gas Company had recently obtained, it would, instead of representing probably the cheapest gas in the kingdom, have represented gas of a very average price—that, if they had reduced the standard to this degree, the gas consumer would have been very much the worse off for the bargain. It was their practice to maintain what they considered was an economical quality of gas to the consumer; and so long as they could maintain that, and reduce the price, they were likely to keep their business and give the consumer a useful article. But if they were to take away from him, as one speaker had remarked, something like 40 per cent. of his light, then he said that the consumer would soon begin to look round for another source; and if gas companies who were pursuing this question of low-grade gas with such determination as at present would only see the ultimate end of it, they would certainly consider it to their advantage to maintain gas at a higher illuminating power. With regard to the qualities of gas in London, Mr. Trewby said there were only two. He (Mr. Carr) submitted there were three—the 16-candle gas of the Gaslight and Coke Company, the 14-candle gas of the South Metropolitan Company, and the 14-candle gas of the Commercial Company. Respecting the 14-candle gas standards, there were two methods of testing; and the consequence was that the South Metropolitan Company, through their method of testing at the 16-candle rate, were enabled to pass off what was actually a 13-candle gas as a 14-candle gas. This was borne out by the fact that this year the Commercial Company, who failed to obtain in a previous Bill this special testing clause of the South Metropolitan Company, had promoted a Bill whereby they could test their gas under the same conditions as the South Metropolitan Company. If the standard was the same, why did the Commercial Company want to alter the method of testing? They wanted to take the candle out of the consumer in the same way that the South Metropolitan Company were doing, and get credit for something they were not giving—for something in which the consumer did not in any way participate. This proposed method of testing the gas was something that was altogether in favour of the Company, and all to the disadvantage of the consumer. He (Mr. Carr) wanted to also say a word on this question of sulphur compounds. The author gave them the statement that out of 692 undertakings in the kingdom, only 51 had sulphur clauses, out of which 21 failed to test the gas. They ought to look into these figures a little further, because they by no means represented what actually took place in the matter of purifying the gas in this country. First of all, there were 692 undertakings, including Scotland. Now it was a well-known fact that the sulphur compounds in Scotch coal gas never reached the statutory limits of the sulphur in English and Welsh coal. Therefore, there would be something like 60 gas authorities that were to-day manufacturing gas from Scotch coal, representing something like 10 per cent. of the make of gas of the kingdom. These must be counted as supplying gas below the statutory limitations as to sulphur compounds. As to the 21 authorities who were under restrictions but did not test, he knew that in many important cases the reason they did not test was that for years and years past they had got to systematical methods which ensured the gas being within the statutory limit.

Dr. RIDEAL: What do you mean by the statutory limit?

Mr. CARR replied from 20 to 30 grains. He believed 20 grains was the lowest. However, those authorities found it was unnecessary to continue the test, because the gas was always properly purified. But the most important point of this question was that of the hundreds of authorities in this country who had no sulphur restrictions established, yet in the interests of their consumers, they were careful to purify the gas for sulphur compounds; and among those hundreds of authorities, were represented some of the largest and most important towns in the kingdom. So the actual fact as to the gas supplied in England to-day was that the great bulk—he should say 80 to 90 per cent.—of the gas supplied was thoroughly well purified from sulphur compounds. So if they got to actual facts, how different the impression it left on the mind from the statement in the paper—that only 51 undertakings had any legal restrictions.

Mr. WALTER HUNTER also referred to the statement in the paper as to the consumers on the north side of the river paying 50 per cent. more than the consumers on the south side; and he said he thought Dr. Rideal had made a mistake there. The Commercial Gas Company had been generally within a few pence of the price of the South Metropolitan Company. He did not pretend to discuss this question from the technical point of view, but as one who was related to the Commercial Gas Company. It seemed to him and his colleagues that the incandescent mantle and cooking and heating had entirely altered the conditions under which gas was burnt. They had the advice of their late Engineer (Mr. H. E. Jones) and also the benefit of having Sir George Livesey on the Board; and he (Mr. Hunter) could not help thinking that Sir George was perfectly right in looking at the fact that they ought to supply gas at the cheapest rate possible. That was the salvation of the whole industry. It seemed to him to be absolutely wrong to enrich the gas in order to make it burn in bad burners, while they had good burners at command. They were taking steps now to supply the latter to their consumers. He had rather hoped that Dr. Rideal was going to treat upon gas testing, because that was undoubtedly the crucial thing. Mr. Carr had referred to the fact that the Commercial Company had got an Act to empower them to reduce the illuminating standard. This was true; they obtained an Act upon a certain basis, part of which was thrown over by the action taken by the Gas Referees. He did not say whether the method of testing according to the Commercial Act was right or that of the South Metropolitan Company. It was a question that ought to be inquired into; and he was glad indeed the Board of Trade had decided to appoint a Committee to investigate the matter. All they wanted to arrive at was the truth, as to what was best to be done. Then he was quite sure they would be satisfied. But they did not want to be bound to give gas of an extra candle in quality—a candle more than another Company who were testing in a different way, which they thought and he thought was fair, because in the Act of 1868 it was laid down that the standard burner should be such as would develop the best illuminating power of the gas.

Mr. JACQUES ABADY (London) said a large proportion of the remarks of the various speakers had been directed to the question of the standard burner; and it had been stated that the present condition of things—having different methods of testing in different districts, and using different burners and different photometers—led to complication, and altogether that affairs were in a muddle. This, of course, depended upon their point of view. His conception of the object of testing gas at all was that it was the basis of agreement between a particular company and the public, obtained through the medium of a parliamentary committee. If a gas company went to Parliament, and said: "We want to test the gas in this particular manner; and tested in this burner, and in this particular manner, the gas we shall supply will be of such and such a quality," that was the basis of a bargain. But because their next-door neighbour did the thing in a different way, that did not lead to any complication whatever. One of the speakers said that the multiplication of burners and methods of testing resulted in endless complication, and that one had no standard on which to compare one company with another. He did not at all agree with that view; and it was met by remarks already made. The only practical basis of either getting concessions from Parliament or comparing one's own quality of gas with that of anybody else, was the thermal unit. In taking a test for 16-candle gas, they had to use the "London" argand burner, and consume 5 cubic feet of gas—that was 3·2 candles per cubic foot; but everybody knew that this had nothing to do with the way the gas was to be used by the consumer. Everybody was aware that the consumer could, with ordinary care, get 25 candles per cubic foot. Because there happened to be a particular method of testing the gas, it did not

prevent the consumer buying a 6½d. incandescent burner; and because a company had to use a "London" argand burner, it did not follow that the consumer should have a "London" argand burner too. The burner simply formed the standard between the company and Parliament; and in that way it was convenient. But, he (Mr. Abady) thought the conditions under which gas was being made, used, and distributed, were altering very much; and he agreed that the thermal unit was the proper basis. It appeared to him that so long as one put, on the one hand, the thermal power, and, on the other hand, the price, and ascertained how many British thermal units, they could supply for a penny, or in fact any other price they liked, it did not matter whether they were supplying 14, 15, or 16 candle gas. But he supposed some practical gas engineers might say there were conveniences in distribution and so on, and that the consumers were better served by the supply of the higher candle power gas. It had been vigorously argued that the reduction in illuminating power was to the benefit of the consumer, because he had to pay less for the gas, and could get a better result out of it with an incandescent burner. This was not his own experience. He did not find that, with gas of 14-candle power in an argand burner, he could get a better result in a Welsbach burner than with gas of 16 or 17 candle power. They must use a proper burner and get the proper proportion of air to gas; and he did think that, if they tested correctly in this way, it would be found that there was almost a sliding-scale, and that they did not get a better efficiency in a Welsbach burner with gas of low calorific power than with gas of higher illuminating power. Here he would direct attention to the experiments of Messrs. Russell and White in America. These gentlemen had read several papers before various Societies in America; and they were worthy of the attention of anybody interested in this subject. It seemed to him that they would have to arrive at the conclusion that the thermal unit was a convenient one; and it appeared to him that it was going to have considerable influence in the future on gas-works practice. If the gas engineer—even if he had to comply with a statutory requirement with regard to illuminating power—thoroughly grasped the idea that he had to supply thermal efficiency, this would alter his methods of working. They used coal to start with, this was put into the retorts, and they got gas and bye-products, most of which had a thermal value—such as the coke and tar; and, therefore, the future gas-works standard should be thermal efficiency. It was by this that the Power Gas Corporation and Dr. Mond, and others had put their producer gases upon the market—they had gone to work scientifically, and had tried to utilize their material in such a way as to get all the thermal efficiency out of the producers that they put into them. He hoped that calorimetry would become common in gas-works. He did not mean by this that, when they were testing by a calorimeter, they should simply put the number of calories down in a pocket-book, and forget all about them; but they must use what they learnt to get all the calorific power possible out of the coal and the products—to attain to a system of efficient working which would enable them to get the highest percentage thermal efficiency from the material used.

Mr. C. E. Jones (Leyton) said it appeared to him the author had made a mistake when he named his paper. He called it "Coal Gas Standards;" and he (Mr. Jones) was in hopes that, when he read the paper, he was to receive some information having for its object the laying down of a positive standard applicable to gas testing. He was, however, disappointed; and he daresay that others were in the same condition. If they were to have a standard that was to be universal, they must have the article to be tested of the same quality everywhere; but this was impossible. Every town had its own standard; and every locality had its own favourite coal for making gas. So long as these conditions obtained, there was no "London" argand, or any other standard of that nature, which was a satisfactory one, and applicable to all cases. But Dr. Rideal went on to open up a very wide field for discussion. The conditions attending gas making were quite different from what they were fifteen years ago. But some 18 or 19 years ago, he (Mr. Jones) submitted a paper to a Society in the Midlands, in which he advocated a reduction of high-power gas to a lower grade; and one of the expressions he made use of in the paper was to the effect that gas of 16-candle power, or anything higher, was of no use to the general public. He adhered to this opinion, and believed they might with safety reduce the standard several candles. The reduction of the standard would be attended by economy, and several advantages in addition to those already named. It would open up a wider field in the coal area and coal measures of this country from which to draw the supply of the raw material. The richer bituminous coals were being rapidly worked out; and, when they were gone, they must devise some other mode of making the article they required. There was a very large area of coal in this country untouched which was perfectly suitable for making gas of 10, 12, and even 14 candles; but it would not make gas of 16 candles, and a large proportion of it would not make a marketable gas of 14 candles. Then with the latter they would have to fall back upon an oil enricher. About the limited supply of coke of which complaint had been made in the previous paper, he was a living survival of the dreadful practice of burning coke in his domestic economy; and during 25 years, he had eaten but little meat that had not been cooked by gas. The use of coke was one which should be encouraged. The author also gave them his views on pressure. His paper, in fact, was a valuable one because, if it did not give them all the information hoped for, it made up by hints. The reference to pressure, to Parliament throttling gas companies, and so forth was scarcely justified, because there was scarcely a gas company in the Kingdom that worked to the parliamentary pressure. They all exceeded it—it was to their advantage to exceed it; and when a gas company found a thing was to their advantage, one might lay his "bottom dollar" that they would adopt it. Then with regard to the number of companies under sulphur restrictions, he was a strong advocate for pure gas, and he always had been. Although his old Company were not under any restriction whatever with regard to sulphur compounds—sulphuretted hydrogen was the only thing recognized—there were less than 10 grains in the gas. He maintained that the gas companies supplied a much better and richer article than was generally supposed; and with respect to pressures, considerable advantage would accrue to the consumers if pressures generally were increased by pressure raisers or some other mechanical contrivances.

Mr. W. Foulis (Glasgow) also remarked that the paper was scarcely what the title led them to expect. It and the discussion dealt more with the question of policy than with that of testing. It was almost impossible, in a short meeting like this, to discuss the question, because it involved a great deal more than the simple one of illuminating power. There was, for instance, the quality of the gas, and the purpose to which it was applied. Then there was another question, and that was, in burning gas in incandescent burners, what really they must depend upon was not calorific value, but flame temperature. This was an entirely different thing to calorific value. They had heard a great deal about the effect which a large reduction of the quality would have upon the consumption of gas. Now, he quite agreed with Mr. Hunter that really the true test was the commercial one. He remembered when they reduced the illuminating power of gas in Glasgow not by 2 candles but by 5 candles, there were told in Parliament by many eminent engineers that they would have to enlarge all their pipes, that the consumption would go up so enormously that they would require larger works, and that the gas consumers would be charged something like 20 per cent. more in their accounts. Well, they reduced the quality by 5 candles. But they did not enlarge their pipes; and the consumers' accounts did not go up. Instead of all this discussion about candles and testing and all that kind of thing, it would be an exceedingly useful thing if they could know what had been the effect of the reduction of the illuminating power of the gas by the South Metropolitan Gas Company from 16 to 14 candles. Had the consumption there for gas-engines and by individual consumers gone up? The Company certainly had not enlarged their mains; and, so far as he knew, their percentage increase of consumption was not abnormal. Therefore, he thought this was the test of the effect of the reduction.

[Mr. Foulis's remarks have been submitted to Sir George Livesey; and in reference to them he writes: "There is not the slightest evidence that the South Metropolitan Gas Company has had any increase of consumption for any purpose as the result of the reduction of 2 candles. The increases of business have been below the average, and have not been greater than the Company's neighbours'. For instance, the Crystal Palace District Gas Company have about the same average increase as the South Metropolitan. The increases ought to have been greater than usual, owing to the very large number of new consumers. The accounts have certainly not gone up. The supplying of suitable flat-flame burners and the extension of incandescent lighting tend rather to a reduction of the accounts."]

Mr. A. F. Wilson (Aldershot) said that, in connection with this question of testing gas, the difficulty lay in the exigent manner in which the tests were performed by the authorities. If a gas company were in the slightest degree below the standard prescribed, they were fined; but when they were ¾ or ½ candle, or even a full candle above the standard, they got no reward for it. Now in connection with the Gas Company with which he had been associated for many years, this was a very important matter. He found, in order to keep up the standard to 15 candles, they had to maintain it at 15¾ candles about 1¼ miles away from the testing-station. No doubt part of this was due to condensation in the winter time; but to a great extent they found the difference was made up by imperfect testing—to exigent testing—and to the feeling that gas companies must be fined if at all possible. This was a point he should like to be taken up in the future. He suggested whether, in future legislation, it might not be possible for gas companies to have some slight allowance below the test without being penalized; so that they might fairly feel, if the average of the tests was up to the standard, they were performing their duty. He said further, if the authorities were exigent in this matter, they were fining themselves, because it would only conduce to the maintenance of a higher price for gas. His feeling was that it was to the interest not only of gas companies, but of consumers and the authorities too, that the gas should be of the quality that could be most easily manufactured, and that was the quality that could be supplied at the cheapest rate. It was to the interest of the public they should have the maximum of advantages in the shape of quality, illuminating power, or calorific value at the lowest price; and it was also to the advantage of gas companies to give it. He thought, as time went on, it was possible the

standard of illuminating power might be reduced, seeing that a large number of their consumers were power users and also users of gas cookers.

Mr. R. Forbes Carpenter said in regard to the value to be attached to the statutory limitations as to sulphur compounds, he thought their imposition had no doubt stimulated chemists and engineers to perfect the method for the removal of the sulphur compounds. The progress that had been made in the chemistry of the subject had not been so great as one could have wished. At the same time, he did, as a consumer, attach very considerable value to these sulphur clauses. In his own experience—having lived in Lancashire, and having returned to London—he knew the great personal comfort they made in the burning of gas. For thirteen years, he lived in a great town where the policy of the Gas Committee (the gas-works there were the property of the Corporation) was to supply cheap gas. But their aim was to supply their gas of a high illuminating power, but without regard to the removal of sulphur compounds; so that 40 grains was not an uncommon figure. This, he could assure them, was a very uncomfortable thing even with what were then the best burners—Sugg's "Christiania" and the argand; and no better burners were to be obtained ten years ago. However, the sulphur clauses had had this value—they had imposed upon the gas engineer the use of the best practicable means of purifying the gas, and of finding out what were the best practicable means. In the evidence Mr. Carr recently gave before a Commons Committee, he said the sulphur compounds could be removed down to 20 grains by means of oxide of iron alone, charged with free sulphur. This was news to him (Mr. Forbes Carpenter), and a matter of great interest, because he knew how difficult it was to manage lime purifiers. He desired to bear testimony to the fact that a large number of gas managers did supply an article far beyond the statutory requirements, because they knew their consumers liked a pure gas. The figures given in the paper did not by any means represent the practice, because the practice went far in advance of what they were required to do.

Mr. J. F. Simmance (London) observed that a great deal had been said about the "London" argand burner, and the way it should be used; but they seemed to have lost sight of the fact that the argand would do one thing in one room and another thing in the next room. They could get, with a consumption of 5 cubic feet per hour, 16 candles in one room, and probably, burning the same quantity of the same gas in the next room only 14 candles. He had known as much difference as from 13 to 17 candles simply by altering the conditions of the room. It was quite obvious that the muddle of which Mr. Carr had spoken did exist. They had no parallel between one gas company and another, and no parallel between any two testing-stations. If the Board of Trade Departmental Committee could only be prevailed upon to look into the question from this point of view—that a room was part of the photometer, and that any two rooms to give comparable results must be fitted up in exactly the same way, and must have the same arrangements by which the same quantity of air could be passed from the photometer to the ventilator in the room—they would realize that it was a most important question, because, without these conditions, they had no means of comparing one gas with another under any circumstances. These remarks applied to any standard of light in which a chimney was used.

Mr. T. Goulden (London) remarked that he should not like the idea to go out that, by the manipulation of standard burners, they were cheating the public of anything that was their due. It was a suggestion that was entirely wrong; and anyone who knew the way they were working in London—who was really acquainted with London working—could not make such a suggestion. He strongly protested against it. The standard burner was, in the first place, designed for 16-candle coal gas; and, as it was designed, it was an excellent standard burner in which to burn that gas. It was designed by Mr. Sugg; and it was a burner that, at the time, quite fulfilled the conditions, that it should be capable of giving the best illuminating power from the gas that was burnt in it. Now it was evident that if they were to burn 14-candle gas, at the rate of 5 cubic feet an hour, in the burner, they would get a stunted flame—nothing like the 3-inch flame which gave the amount of air proportional to the hydrocarbons that were passing through the burner, and which gave the best result for the combustion of the hydrocarbons. On the contrary, they had a huge excess of air; and such a system of using the burner was one which was not for the purpose of developing the illuminating power of the gas, but for the purpose of killing the illuminating power. All he wanted was that due credit should be given to gas companies for what they were supplying to the public; and he strongly protested against any suggestion that they were endeavouring to filch something out of the public pocket. As to the Welsbach burner, there was no doubt that, with different qualities of gas, as they went up the scale, they could get higher results from the burner. As a rule, the flame intensity of which Mr. Foulis had spoken, followed the calorific value of the gas. It was one thing, however, to arrive at a scientific result, but quite another to realize the same results in practical use. They might have a gas of high calorific value and high illuminating power; but it did not by any means follow that an ordinary member of the public would get the same increase of illuminating power from it as the scientific man in the laboratory. The mantle had much to do with this. Unless the mantle properly enveloped the flame, and unless it was carefully made and tempered, the best results could not be obtained out of the Welsbach burner. Another point was the necessity of proportioning the different parts of the incandescent burner to the constituents of the gas to be burnt in it.

Mr. H. E. Jones (London) said the question underlying all this was much more important than the one as to whether the gas was going to be burnt in the burner best fitted for it. What they wanted to remove were all the obstacles in the way of making a gas they could sell much cheaper than the ordinary illuminating power gas. There was a demand for fuel gas and for power gas everywhere, and especially for domestic purposes and what they had got to get rid of were all the trammels and fetters that surrounded them, and the dodge of using the argand burner—and an awkward, miserable dodge it was too—of Mr. Carr or somebody else. Whether they used a flat-flame burner or a Welsbach burner, what they wanted to do was to sell gas at 1s. 6d. instead of 3s. per 1000 cubic feet.

The Chairman said that, while he must confess, after seeing the title of the paper, he was disappointed with the manner in which the question of standards was dealt with, they had to thank Dr. Rideal for giving them a paper which had provoked such a very interesting and profitable discussion. With regard to the question that had chiefly occupied the speakers—that was, the reductionof the illuminating power of gas—he thought they ought to bear this in mind, that gas companies had lost to the electric light a certain proportion of business. He did not say that was permanently lost; it might be recovered. But, in competing with a light the chief recommendation of which was its hygienic superiority, it seemed to him they ought to think twice and thrice before they entered upon the contest with an illuminating power reduced and an increase in the impurities in the gas. The suggestion that by leaving the sulphuretted hydrogen and sulphur compounds in the gas, they thereby got a smell which would be of some mysterious value (laughter) was, he thought—well, it ought to be marked where the joke came in, and where the thing should be taken seriously. Mr. Jones had spoken of the desirability of making cheap gas; but cheapness in money was, after all, only one element in the calculation. They might have a material selling at a very low price; but it might be very dear to the purchaser. Then the direction they must follow, and what they wanted to do, was to give the best value in the article they supplied for the money paid. [Mr. H. E. Jones: That is what I mean.] As to the incandescent burner, the result of a long series of careful experiments with 16-candle and 14-candle gas showed that there was a reduction of 10 per cent. in the value of the incandescent burner with 14-candle gas compared with 16-candle; while there was a reduction of 20 per cent. in the value of luminous flames, and about 7 per cent. in the calorific value. These were elements that entered into the calculation of the value of the gas that was distributed.

Dr. Rideal, in replying, remarked that several speakers had already dealt with Mr. Trewby's points; but he should like to make a correction of the 50 per cent. now that they had the actual figure given by him. Really, however, it did not affect the argument. Mr. Trewby said there was 18 per cent. difference in the actual cost of gas between the South Metropolitan Company and his Company. The point raised was the price for supplying heating gas for the electric power station at Charing Cross, and the difference in price for illuminating power was not the point at all. Although 18 per cent. represented the difference in the actual price of the gas, it did not represent the actual difference in the price of gas for heating purposes at the place mentioned, because the price must be valued against the calorific value of the gas. As to there being three qualities of gas supplied in London, it was mentioned in the paper that the South Metropolitan Company and the Commercial Company supplied gas of 14-candle power; but the latter Company wished their gas tested in the same way as that of the former Company, which showed that they did not consider the two standards were the same, though they were the same on paper. The question of pressure was a very important thing. It was quite possible by increasing the flow of the gas through the mains to make up for any decrease in the calorific or illuminating value—that was, if the present mains were sufficiently fit to stand high pressures; and this must reduce the cost of distribution. As to Mr. Trewby's point about carburetted water gas, he (Dr. Rideal) did not say it would not carry; the points were with reference to volatile hydrocarbons, and as to the sulphur contents of the enriching benzols increasing the quantity of sulphur in the gas. They all hoped for great things from the Board of Trade Committee on this question of testing. As the time at his disposal had passed, he would not deal with all the questions raised in detail; but he thought that, reading between the lines, they had arrived at the point that the standard for illuminating power was an absurd and indefinite thing. The British thermal unit was the standard used in all engineering industries; and why not apply it to the coal gas industry? They had in the British thermal unit a definite unit of measurement of the quantity of gas passing through the main, under a definite pressure. Let them fix their pressure and their flow of gas of a certain calorific value, and then they would have the quantity of thermal units delivered to a particular houses which could be automatically recorded, and the consumer would pay for this source of energy just in the same way as he would pay for any other source of power. This was the solution to which they were coming of the problem now before them.

ELECTRICIANS, GAS-ENGINES, AND PRODUCERS.

After the Presidential Address last Wednesday at the Engineering Conference (see p. 889), the Machinery Section met at the Institution of Mechanical Engineers; and during the sitting Mr. H. A. HUMPHREY contributed notes for discussion on "Internal Combustion Engines for Driving Dynamos." The following are extracts from the notes.

There are now fifty firms manufacturing large gas-engines of 200-horse power and upwards. Almost all these firms have entered this new branch of engineering during the last five years; and the large gas-engines now running have been constructed, with but few exceptions, during the last three-and-a-half years. The number of gas-engines above 200 indicated horse power (made by some of the principal firms), now completed or on order, number 498, having an aggregate capacity of 310,865-horse power; and of these 390 engines are for dynamos, and give collectively 198,405 indicated horse power.

The central-station engineer is now fully alive to the fact that the gas-producer and gas-engine constitute the cheapest means of generating electric power where coal is the basis of the energy. The internal-combustion engine is rapidly attaining to sizes of units which are large enough to suit even the big tramway-stations; and, when properly designed, has proved as reliable for driving alternators in parallel as the best steam-engine.

One of the first types to gain prominence was the *vis-à-vis* engine, manufactured by Messrs. Crossley Bros., who make engines of 500 and 600 horse power, with two cylinders; and the Gasmotoren-Fabrik Deutz, who have carried this type up to 1200-horse power, using four cylinders. Probably no more engines of this type will be made on the Continent, as the Deutz firm have abandoned the design in favour of double-acting single and tandem cylinder engines. Consequently, although this *vis-à-vis* type has done excellent service, and is now in use for driving alternators in parallel on a large scale, little need be said about it in face of the change to the double-acting type which is taking place.

Many attempts have been made to get over the difficulty of a piston-rod stuffing-box; and Messrs. Dick, Kerr, and Co. years ago constructed and ran at Belfast engines with double-acting pistons and piston-rod glands. The solution of the problem has, however, come gradually; and the Cockerill Company, followed by numerous other makers, have now examples of efficient stuffing-boxes fitted in the closed ends of gas-engine cylinders and giving no trouble. Once this difficulty is removed, the gas-engine must logically be manufactured as a double-acting machine; for, by simply duplicating the valve-gear, twice the power and twice the number of impulses are obtained from the same size of cylinder without increasing any of the working stresses. So completely has this fact been recognized, that all the leading makers now construct double-acting engines; and powers of 1000 horse with single-cylinder engines, and of 4000 horse with double-tandem engines, of the double-acting type, are readily obtainable. Nearly all the important orders which are now being placed for large gas-engines are for the double-acting type; and the various types give thoroughly efficient prime movers for central-station work. In fact, the tandem-cylinder engine and the vertical two-cylinder engine are among the chief favourites on the Continent and in this country.

Descriptions of numerous makes of engine were given by the author; and later in his notes he said that, in his opinion, sufficient attention has not been given to the construction of gas-engines intended to take a supply of both gas and air, separately stored under pressure. For central stations of large size, the previous compression of the gas and air, so that they may be drawn as required from reservoirs, has much to recommend it, and involves, with proper precautions, no special danger. The advantage of the two-cycle gas-engine would then be attained, without the complication of each engine carrying its compressing-plant, together with all the extra valves and gear required. Also, there is no reason why the heavy and somewhat noisy cam-gear on gas-engines should not be replaced, and the valves operated by compressed air, or even high-pressure burnt gases stored from the motor-cylinder itself, controlled by a small rotating valve.

The term "internal-combustion engines" embraces oil-engines; but oil-engines above 200-horse power are rare, and cannot compete in cost of fuel with gas-engines using cheap producer gas, especially when the system of recovering the ammonia from the coal—as in the Mond producer plant—is available.

In general, a gas-engine, giving at least one impulse per revolution, is necessary for all central-station direct-coupled dynamo-sets; and in cases of alternators working in parallel, engines should be chosen which give two impulses per revolution. The large central electric stations of the future will employ producer gas and gas-engines; and several existing stations with steam plant are to have gas-engines for additional power with the ultimate object of the entire replacement of all steam plant.

Discussion.

The following is not by any means a full report of the discussion, but merely an indication of a few of the points raised:

Referring to the statement of the author that the central-station engineer is now fully alive to the fact that the gas-producer and gas-engine constitute the cheapest means of generating electric power where coal is the basis of energy, Dr. A. B. W. Kennedy said, although Mr. Humphrey "chucked this statement over his shoulder" in such a hasty fashion, he (Professor Kennedy) was afraid that there were a great many central-station engineers who had studied this problem very carefully from the point of view of money, economy, and speed, who would do their utmost to use power-gas engines, if they found they were going to be really the thing wanted. However, there were a great many of them who had failed somehow to convince themselves of this fact at present. Personally, he was unprejudiced in this matter, as one of the first central stations he designed was driven by gas-engines. Mr. W. J. Crossley held that the *vis-à-vis* type of engine was one of the simplest, the most useful, and cheapest engine to build; and he believed that for types up to 20 or 22 inch cylinders, it would always be the cheapest, simplest, and most economical. He gave his reasons for the opinion. A complaint was made by Mr. Michael Longridge that he had endeavoured to get tenders from English firms for a 500-horse power gas-engine; but to his astonishment he found that, save at Messrs. Brunner, Mond, and Co.'s works and one or two other places, experience with these large engines seemed to be practically non-existent in this country. The large gas-engines to which the author had referred were mostly Continental ones, and were working with blast-furnace gases. He had felt great diffidence in recommending anyone to go in for large gas-engines, although, to his mind, if they could be brought to a practical state, they were likely to prove economical for many purposes. A number of questions were put by Mr. Mark Robinson; but Mr. Humphrey could not reply to them in the time at his disposal. However, one of them was, if certain cooling arrangements worked well with blast-furnace gases, to what extent might they rely upon their working well with gas containing greater heating power—that was to say, gas having large percentages of hydrogen.

Commenting on Dr. Kennedy's remarks, Dr. Hopkinson pointed out that, although the inherent fuel economy of the gas-engine was higher than in the best types of steam-engine, it was not so much so as to put the steam-engine out of comparison with the gas-engine; but, when other factors were taken into account, then the result was very favourable to the gas-engine. The stand-by losses were enormously less. The producer could be stopped immediately by cutting off the blast; and the stand-by losses in connection with the engine could be stopped equally instantaneously. If Dr. Kennedy would look at the matter from this point of view, he would find ample justification for Mr. Humphrey's contention, that the gas-engine must be the type of motor for the future in electric light stations. He believed that the number of engines (completed or on order) above 200-horse power was understated by Mr. Humphrey. It was extraordinary to find how very few of these engines were working in this country. There was no doubt that experience was tending altogether in the direction of double-acting single cylinder engines. It was remarked by Mr. H. Davey that in blast-furnace gas they had a producer which gave gas practically for nothing, and without any of the difficulties which attended the use of gas-producers. He understood that producers could be worked satisfactorily on a large scale; but what was wanted in the application of the gas-engine was a producer which would take the place of the steam-boiler. It seemed obvious that, if they could get a satisfactory producer which could be worked at the same expense as the steam-boiler and so on, and could get 70 to 80 per cent. of the calorific value of the fuel in the gas, the gas-engine must be a most economical prime mover. He was surprised he did not find stations with gas-producers and gas-engines of a moderate size.

Credit was taken by Major-General Webber for having been the means of putting gas-engines up at Belfast in connection with the electric light station there. He thought that the last speaker had really hit the right nail on the head, and that was in the want of a gas-producer which would do the work required and no more. Those who were generating electricity did not want to be troubled with bye-products; they only required a producer which was simple and easy to work. Those who could buy Mond gas from the main and use it in a gas-engine would unquestionably do so with great economy. Professor Burstall at present could not look at this matter in quite the optimistic way that Mr. Humphrey did; and, for his own part, he should like someone to take the first plunge. To Mr. Booth it seemed that blast-furnace gas was applicable to gas-engine driving; but Mond gas was not so suitable for high pressures, as, with the compression of hydrogenous gas, premature explosion occurred.

There were other speakers, and then Mr. Hugh Campbell pointed out that there were producers in abundance of a very satisfactory and efficient character for gas-engine work; and it was not necessary that producers should be accompanied by ammonia recovery. The gas-engine makers of this country had ground for complaint. Reference had been made to the advances of the German makers over those of this country. This had simply arisen through the power users of this country not giving the gas-engine makers a chance to show what they could do. The first firm to give the makers an opportunity was Messrs. Brunner, Mond, and Co., with the result that British makers had shown they could do what was required of them. As to the double-acting engine, he thought Mr. Humphrey was a little

optimistic as to its satisfactory working. His own information was that one of the large makers had not quite realized expectations. This was not due to trouble caused by the stuffing-box, but owing to the reversal of the pressure in the cylinder acting on the bearings. Gas-engine makers had been accustomed to the explosive force being in one direction; but with double-acting engines, this was reversed. It was thought by the Hon. C. A. Parsons that the meeting had not before it the data to consider the subject justly, in respect of the costs of running, the capital expenditure, and liability.

Among the points of his reply, Mr. Humphrey acknowledged that the *vis-à-vis* engine was doing excellent work. He was afraid it was some time since Mr. Longridge made his inquiry for a 500-horse power engine; he would certainly not find any difficulty in getting one here now. As to relative cost, he knew of a steam-engine and gas-engine running in the same building under the same superintendence (this was a case of electricity work), and the costs for the steam-engine were twice those for the gas-engine. The point as to producers had been answered by Mr. Campbell. It had been stated by Mr. Booth that gases rich in hydrogen were not suitable for use in gas-engines. Surely this was a mistake. Mond gas contained 29 per cent. of hydrogen; while lighting gas, with which most of the experimental work had been carried out, contained 50 per cent. With lighting gas, they could go up to compressions of 120, 160, and even 180. Gas containing only 29 per cent. of hydrogen must be more difficult than the lighting gas to ignite; and his own experience with compressions up to 120 showed that there was no trouble from pre-ignition.

THE JUNKERS CALORIMETER.

As mentioned in the notice of the *conversazione* at the Institution of Civil Engineers, on the occasion of the Engineering Congress last week, Dr. Samuel Rideal showed one of the above-named instruments, in connection with his paper on "Coal Gas Standards." It has been already described in our columns, but as it has now been adopted as a standard in many gas-works in the country, the following particulars may be of interest.

The principle on which the calorimeter works is that of ascertaining the calorific power of gas from the number of degrees to which the temperature of a certain weight of water is raised by the consumption of a definite quantity of gas. The calorimeter has a maximum absorbing capacity of 2500 calories per hour; the quantity of gas burnt during the tests should therefore be so regulated that the flame only produces from about 1000 to 1500 calories in this time. This will give an average of from 4 to 8 cubic feet of illuminating gas per hour.

The first operation is to fill the calorimeter with water until it comes through the overflow, which must be working freely; then insert the burner, and with the flame burning and the water flowing the temperature at the discharge will begin to rise, and the exit thermometer will remain stationary. A cock is supplied which regulates the quantity of water passing through the calorimeter; and from 10° to 20° C. is the most suitable rise in temperature to work with. When the pointer of the gas-meter passes any whole figure, the hot-water tube is shifted from over the funnel into the measuring glass, and the temperature of the hot water is taken by the thermometer at five or six intervals while the glass is being filled. The cold-water thermometer will remain stationary. The reading should be noted once only. As soon as the quantity of water escaping reaches the 2-litre mark, the gas should be turned off, and the quantity shown by the meter read.

When the calorific value of 1 cubic foot of gas is represented by H, the quantity in litres of water heated by W., the difference in the temperature, in degrees Centigrade, of the two thermometers by T, and the quantity, in cubic feet of gas burned during the experiment by G, the formula $H = \frac{W\,T}{G}$ gives the calorific value of 1 cubic foot of gas. By deducting from this the quantity of water condensed during the test in the apparatus, allowing 0·6 calorie for each cubic centimetre of water, and dividing the product of these two figures by the number of cubic feet of gas burnt, the number of calories to be deducted from the value obtained above so as to get the net calorific value of a cubic foot of gas will be obtained.

The following examples, taken from various illuminating gases, will show how the calorific value varies per candle :—

Quantity of Gas.	Illuminating Power per Candle.	Net Calorific Power.	Calories per Candle.
Power gas	12·0	137·0	11·40
" "	13·0	135·0	10·50
Coal Gas	16·6	142·6	8·50
" "	17·3	145·6	8·40
Coal and cannel gas	17·3	145·7	8·40
Cannel gas	28·7	206·7	7·26
Carburetted water gas	17·4	132·9	7·60
Mixed coal and C. W. G.	17·0	143·6	8·40

To convert calories into British thermal units, these figures have to be multiplied by 3·96.

A GAS EXPLOSION CAUSED BY ELECTRICITY.

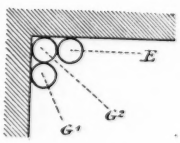
By M. Ad. Bouvier.

[Extracts from a Paper read before the Société Technique.]

The presence in a town of systems for the distribution of electricity for lighting and motive power, and more particularly for tramways, constitutes a risk of damage to gas and water mains, not merely on account of the stray currents and resulting electrolysis to which electric tramways with earth and rail returns give rise, but also of contacts which may occur between an electric conductor and a gas or water pipe. It is difficult to entirely avoid this contact; and the consequence has been the occurrence of a certain number of accidents. Attention was directed to this matter early in 1901 in a letter by Mr. [now Sir] George Livesey to the "Journal." In the following September, at the meeting of the Swiss Association of Gas Engineers at Basle, M. Peter, the Municipal Water Engineer of Zürich, cited the case of a 3-inch water-main which had been completely destroyed by electrolytic action caused by stray currents; while M. Lindley, the reporter of the Special Committee nominated by the German Association of Gas and Water Engineers, alluded to the subject at the congress in Düsseldorf in June last year. The question for gas managers is how contact between the electric current and their mains, with consequent damage and the risk of explosion and fire, is to be avoided. By way of contributing to the investigation of this subject, I will briefly describe an explosion—fortunately not a very serious one—which happened at Lyons last autumn, with the view, if possible, of eliciting opinions as to the protective measures to be adopted.

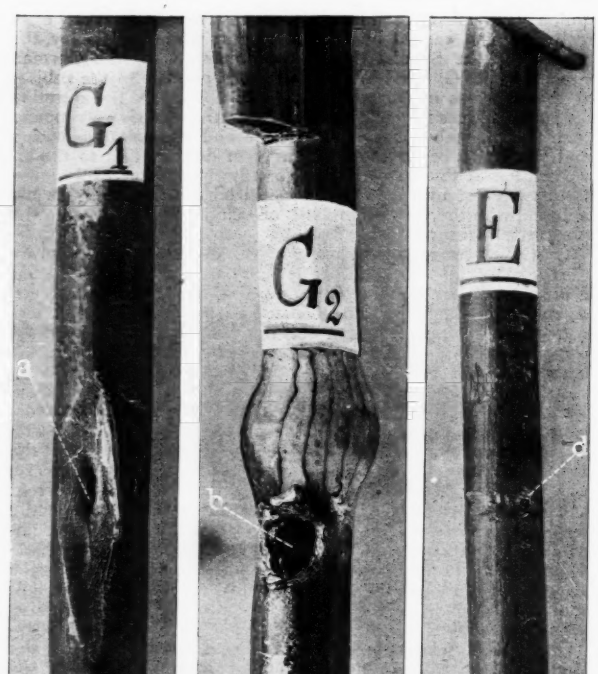
On Oct. 15, 1902, an explosion of gas occurred in a room on the third floor of No. 39, Cours de la Liberté, wrecking the walls, ceiling, windows, and furniture. A line of electric trams runs down the thoroughfare, and the metal posts by which the trolley-wire guide is supported carry also the gas-lamps. One of these posts faced No. 39, and on the morning in question some workmen in the service of the Tramway Company had been fitting the cross suspension wire. About nine o'clock, a short-circuit (really the second) was produced between the main trolley wire and the gas-lamp. The sparks attracted the attention of those at hand, who at the same instant heard the explosion. It is probable that the current gained access to the rising main with which the house was fitted up. It was at once concluded that the electric current had been the cause of the explosion. In the course of friendly negotiations between the interested parties, the Tramway Company agreed to make good the damages, although part of the blame evidently should fall on the municipal authority for permitting the attachment of the gas-lamps to the tramway poles; the permanent contact thus made between the tramway and the gas system being a source of danger.

On an investigation being made at the scene of the explosion, it was found that the gas-lamp showed traces of short circuit in the shape of slight fusion, the insulating ball of the trolley wire having been renewed. Above the closet in the house was a cupboard used as a receptacle for soiled linen, and traversed by three parallel lead pipes. The pipes, grouped as shown in the diagram (G^2 conveying the gas from the meter, which was in the kitchen), ran at the angle of the ceiling and the wall along the whole apartment. The pipe E, by the side of G^2, conveyed water to the kitchen; and close under the latter pipe ran G^1, leading the gas to the meter. At first sight, the state of things here described is not sufficient explanation of the explosion. The pipe G^1 was slightly flattened; and for an area of a few square centimetres, bounded below by a trace of partial fusion, there was a rent from 2 to 3 centimetres (0·8 in. to 1·2 in.) in length, with clean edges, the presence of which it was difficult to explain. (See photograph, p. 900.) This rent, shown at *a*, was actually an effect, and not the cause, of the explosion. The appearance of the wall, which had a radiating halo of soot, supported the assumption that a jet of gas escaped from this aperture, and became ignited, but was not sufficient to account for the explosion. Damage had been done to the pipe at this point by the clumsy use of a soldering-lamp by a plumber, who must have directed his flame for a moment on to the pipe. Its substance was thus weakened from the outside; for, on cutting a section, it was found to be circular and intact within. Evidently, then, the explosion, however it originated, produced a rent in the pipe at a point already weak, and thus gave rise to a trifling escape of gas.



The real cause of the explosion had still to be found. The hall had suffered very greatly. The ceiling was fractured in several places, the partition walls were destroyed, and other damage was done. A careful examination of the upper part of the place disclosed signs of burning over a space of some 40 centimetres below the ceiling; the raised parts of the tapestry paper being scorched to a brown or black by the fire. This observation made it possible to estimate the volume of escaped gas at about 4225 litres—a quantity quite sufficient to give rise to the explosion. The pieces of the pipes G^1, G^2, and E, shown in the photograph, furnished evidence that the principal escape *b* was caused by

short-circuiting about 8.30 a.m., and that the gas was ignited by a second passage of the current. Imperfect contact between the pipes G^1 and G^2, strongly united with solder, on the one hand, and with the water-pipe, which formed a very good "earth," on the other, had produced, at the contact of a bracket and the pipe G^2 at the point *b*, the fusion of the gas-pipe at a temperature equal to or above 300° C. (572° Fahr.). The pipe showed a perforation about 1 centimetre (0·4 inch) in diameter, and crater-like in its appearance, on the right of the supporting bracket, the pointed portion of which pierced the water-pipe E. Traces of this perforation are shown at *d*. Some solidified drops of metal were found on the interior surface of the bracket which had been for some time in contact with the pipe G^2. The contact between the two gas-pipes, soldered to each other, and the water-pipe, was ensured by the bracket; but, being imperfect, it caused considerable rise of temperature, fusion of the metal, and escape of gas. A second contact would have produced an electric arc capable of igniting the explosive mixture.



When it was found that a considerable escape of gas was taking place, all fires and lights were extinguished, the gas was turned off at the meter, and a message sent to the Gas Company. In the interval, short-circuiting took place, for the same reasons and in the same way, for the second time. The temperature rose at the point of contact between the gas and water pipes to more than 600° C. (1112° Fahr.), the explosive mixture ignited, and communicated the fire to the entrance hall, where the explosion took place. A witness declared that he was aware of at least two short-circuitings within a quarter of an hour of each other, during the repair of the trolley wire by the servants of the Tramway Company.

After ascertaining that the electric wires and connections in the rooms had no contact with the gas-pipes, some experiments were carried out by experts. A battery of accumulators was connected to the rails on the one hand and to the gas-lamp on the other, through a rheostat and ampere-meter. A second ampere-meter was placed between the two gas-pipes and the water-pipe at the point under examination. Three experiments in succession showed that two-thirds of the current thrown off between the rails and the lamp made its way into the house by the gas-pipes, and returned to earth by the water-pipe. The proof was perfectly clear. For a current of 9·2 amperes, the resistance of the whole circuit of gas-pipes, water-pipe, and "earth" corresponded to a fall in potential of 1·6 volts. The resistance was thus 0·17 ohm for the whole of the derived circuit. Admitting the normal tension between the trolley of the tramway and the rail to be 500 volts at this point, it follows that the electric current which traversed the lamp and its branch-connection at a given moment was 500 : 0·17=2940 amperes. The current in M. Laplace's room being practically two-thirds of the total, it follows that the current passing through the lead piping in the room might have reached 1900 amperes in the case where the actual contact was as good as that in the experiment. Evidently, therefore, the contacts between the trolley, the wire, and the gas-lamp were imperfect on the day of the explosion. Contact was also imperfect between the gas and water pipes; and, by a combination of circumstances, large currents gained access to the room—more than sufficient to cause the fusion of the metal, create an escape of gas, and then ignite it. Thus the first contact between the trolley and the gas-lamp caused a short-circuit in the room, melted the lead of the piping, and in a few minutes gave rise to a considerable escape of gas. A second short-circuit ignited the explosive mixture.

Passing now to the general question of accidents due to electrical contact with gas-mains, three principal cases are deserving of attention. First of all, in the accident of the 15th of October—due to a rare coincidence of circumstances, and to be mentioned as an isolated case—the electric current found access to the gas-pipes by an underground way. There was complete contact with the service-pipe beneath the pavement. Events proved what had been already supposed—that the subterranean gas-pipe was a bad "earth," even in the case of the Cours de la Liberté, where a metallic circuit (continuous, except at the junctions) existed between the points of entry and emergence of the current. The current took the course of the branch-pipe to the gas-lamp, the pipe under the pavement, the rising main in the house, and the lead service-pipe leading to the meter. It did not meet with any real resistance, and it was before the meter was reached—at one of the points where the junction of the pipe formed an electrical resistance—that the current returned to earth by way of the water-pipe. This case must evidently be a rare one, as it implies the support of the gas-lamp and the tramway trolley wire by the same post. Nevertheless, contact of the trolley can happen in the case of any street-lantern. To avoid the accident of which I have been speaking, the lamp should have been electrically insulated from the gas service-pipes in the house, whether or not it was in good contact with the earth; or the branch pipe should have been insulated from the main.

A more striking case is that of electrical contact coming about directly with the gas-supply system in the house. In the first case, the rising main was positive in regard to the interior piping. In the second, the latter will be positive in regard to the main. The system also offers resistance to the current in its junctions, meter connections, &c.

The third form of accident arises from current strong enough only to cause electrolysis. The danger-point is where the current leaves the gas-main. At this spot the current removes from the metal a portion of material in order to convey it elsewhere—generally to distribute it in the soil as a metallic salt. The phenomenon frequently occurs in gas-mains (this is the most serious form), or in branch-pipes which happen to lie in the path of vagrant currents. It usually arises from the rail of an electric tramway, or from a continuous-current main below the ground—uninsulated or badly insulated—running near a water-main. The latter forms an excellent "earth" return for the current. Imagine, for example, a gas-main placed in the ground between the rail and the water-main. A portion of the return current of the tramway will, at a given moment, almost certainly pass from the rail to the earth as a vagrant current, proceeding in the direction of the water-main. In so doing, it traverses any metallic pipe that may be in its path—*i.e.*, our hypothetical gas-main—and produces corrosion at the points where it leaves it for the water-main.

Electrically speaking, a water-main in the neighbourhood of a rail is a "low point"—a sort of drain in a drainage system—and is a collector of vagrant currents. When the latter encounter a gas-main, they traverse it up to the next junction, where they have to rejoin the water-main. When the currents meet on a service-pipe—say, to a house, as frequently occurs in Paris—or on the trench of a gas-lamp, they follow the pipe as far as the water-main, and then run to it. In the two cases, the main or the branch-pipe is the spot where the metal is attacked; and a slow perforation takes place, causing inevitable leakage and occasionally accidents.

The remedy suggested by the experts—to have a metallic connection between the gas and water mains—would merely reproduce the dangerous conditions existing in the case of M. Laplace's house. Should the proposal be officially made, the gas industry should agitate against it. To the reasons already given, the fact may be added that no contact will remain perfect; and an imperfect electrical contact between the gas and water mains would involve considerable risk. Continuous-current mains below the ground, capable of giving rise to vagrant currents, should be carefully surveyed, and the electricity supply companies held responsible for the results of loss of current. There is still greater reason to survey electrical tramways with return by the rail. As their contracts indicate that there should be a maximum of resistance in the length of the rail, and a maximum difference of potential between the rail and the earth, steps should be taken to check the proper working of the tramways in these respects.

Manchester and District Junior Gas Association.—The next meeting of the Association will be held on Saturday, the 27th inst. On the invitation of Mr. W. Severs, a visit will be paid to the Wilmslow Gas-Works; and, through his kindness, permission has also been obtained to visit the water-works.

THE CHEMICAL INDUSTRIES OF CANADA.

At the Meeting of the Canadian Section of the Society of Chemical Industry in Toronto a short time since, the Chairman (Dr. W. R. Lang) selected the above subject for his address. He explained that his reasons for so doing were that the development of the industrial resources of the Dominion during the past decade had been remarkable, and that the extent of it was almost unknown to the members' colleagues in Great Britain. The latter remark should no longer be justifiable; for Dr. Lang produced an address of extraordinary scope, in which he traced the progress of fourteen different substances, from common salt to asbestos. We select from the full text of the address, given in the "Journal" of the Society, a few passages bearing upon subjects in which our readers are interested.

It appears from the section of the address specially treating of coal tar and asphalte, that very little tar distillation is carried on in the Dominion, owing to the tar produced in the gas-works being too thick for treatment with any degree of success. It is mainly used for saturating paper, which is employed largely as a waterproofing material by builders. Some is boiled down into pitch; but fully one-half of the tar produced is exported to the United States.

Asphalte occurs naturally in several varieties as albertite, found in King's and Albert Counties, New Brunswick, and as maltha, one of the stiffer petroleum compounds, which is not of much importance, however, being almost too hard for use in street paving. Up to 1898, albertite was employed in gas-making, and much of it was shipped to the United States; but the original supply is now exhausted.

In dealing with the extraction and refining of metals, Dr. Lang necessarily made reference to the conversion of iron into steel by open-hearth furnaces and the use of coke-ovens; and he stated that the gases produced in these ovens are used in the furnaces; the other bye-products—viz., coal tar and ammonia—being also collected. The ammonia is converted into sulphate by neutralizing it with sulphuric acid, which can be obtained from the pyrites separated from the coal in the preliminary grinding and washing processes to which it is subjected, and is principally exported to the United States, the West Indies, and Glasgow. The coal tar at present finds a market in the States, at Montreal, and other points in Canada. Recently arrangements have been made with an English chemical company to locate at Sydney. The works are now in process of construction; and all the coal tar produced will be utilized for the manufacture of the numerous products of distillation.

The twelfth section of the address was devoted to natural gas and petroleum. The existence of natural gas in Ontario was first discovered in 1889, being found in two well-defined areas, as the Essex County field and the Welland County field. It is chiefly near Buffalo, on Lake Erie, and near Windsor, Ontario, that the largest supplies are met with, though practically it may be obtained in small quantities in nearly every part of the Niagara peninsula. In 1901 there were 158 wells in operation, and 368 miles of piping were needed to distribute the gas. Much of the gas produced in Essex County was formerly led across the river to Detroit by pipe-lines; but, on representations made by the people of the Essex district, to the effect that the supply of gas was not sufficient for home consumption, the Ontario Government passed an Order in Council, in October, 1901, prohibiting the gas from the Essex field being exported to the States. None of the product of this field is therefore now being sent across the Detroit River. It is, however, still exported from the Welland field to the American side of the Niagara River, chiefly to Buffalo (N.Y.). The landowners on whose farms the wells are located get their gas free, in addition to being paid for the use of their land. The value of the gas produced in Ontario during the last ten years shows considerable fluctuations; being somewhat less in 1901 than in the previous year, due, no doubt, to the Government prohibiting its export.

Petroleum is one of the chief mineral products of the Dominion, though as yet the output is not sufficient to meet Canada's needs. The principal seat of the industry is at present in Ontario, where commercial quantities are found in the counties of Kent and Lambton. In the former, there are two oilfields—one at Oil Springs, extending over 1200 acres, and the other in the Petrolea district, 20 miles long by 2 miles wide. In Lambton County, the industry dates back to the year 1862. Petroleum is also found in Quebec, Nova Scotia, and New Brunswick; and boring operations that have in recent years been carried on at Athabasca, near Edmonton, in the North-West Territory, point to a likelihood of that part of the country contributing largely to the future supply of mineral oil. The industry is one of the most highly organized in the Dominion. The system of drilling and pumping now used—the "jerker-line" system—enables a well yielding from 8 to 10 gallons a day to be profitably worked. This system has gained for itself a world-wide reputation. It is used in Galicia, Russia, Afghanistan, Burmah, India, Italy, France, California, and Australia. Its advantages are numerous. A central engine can operate a large number of wells; and on one property near Petrolea, 233 wells, scattered over 400 acres, are worked by a single engine. It is estimated that to sink a well 500 feet in depth costs only $125. In 1900, there were approximately 10,000 wells in operation, yielding on an average 71 barrels of oil each.

The refining side of the petroleum industry is largely in the hands of the Imperial Oil Company, who some years ago absorbed several other concerns, and of the Canadian Oil Refining Company. The plant of the former at Sarnia has a capacity of 60,000 barrels of crude oil per month, and the market for their products reaches from Halifax to Vancouver. Many of the bye-products of the refining process find a market in England and in Spain. The latter Company have erected an up-to-date plant at Petrolea, on the site of one which was in operation some years ago, where all the products will be manufactured that modern science shows can be obtained from petroleum. Improvements in methods of retorting recently led to a considerable quantity of the crude oil being used for making gas—3½ million gallons being an estimate of the amount so employed.

There has been a slight falling off in the production of oil during the past ten years. Calculated as "crude" oil, the output in 1891 was 27 million Imperial gallons, and in 1901 a little over 26½ millions. A slow process of diminution seems to be going on in the area at present productive, and a falling off must be looked for from year to year unless this is counteracted by an extension of the oil-bearing territories. Probably, the field about to be exploited in the North-West will alter the position somewhat, and an increase in the output may be confidently looked for.

THE GIROUD "VERIFICATEUR."

At the recent Meeting of the Société Technique, the members had before them a paper by M. Giroud, describing his "Vérificateur" for indicating the specific gravity, illuminating power, and calorific value of lighting gas. The following is an abstract translation of the paper.

At a time when the changes in gas lighting which are becoming more and more general are the cause of heating rather than lighting power being sought for in gas, it seems *à propos* to place at the disposal of the gas industry a simple and easily managed apparatus which will show the value in respect of heating power of the gas made, either from different coals, or by admixture of several gases. In order to achieve this result, the author has endeavoured to utilize the resources of his little "vérificateur," which is already well known. This consists of a volume regulator or very sensitive rheometer and of a balanced gasholder having a scale by which small volumes of gas may be measured with great precision.

As the light rheometer regulates very exactly the flow of a volume of gas through a constant section and under constant pressure, it was thought that this gas could be burnt under conditions which were always precisely the same, and the heat produced could be caused to heat a pyrometer. It was argued from this that, if the same test were repeated for two gases, and the pyrometer were heated to the same degree, a comparison of the volumes of gas necessary to produce this same rise of temperature would afford a study in comparative calorimetry. The pyrometer which appeared the best and simplest was the mercury thermometer; and this was adopted.

In order to obviate fluctuations of the surrounding temperature according to the seasons and districts, it was necessary to choose a starting point above the maximum of these variations; and 50° C. was adopted. Neither could the boiling point of mercury be approached; so the maximum temperature of 250° C. was settled upon. These temperatures gave a range of 200°, which appeared quite sufficient. In order that the test should be of sufficient duration, while avoiding a great increase in the mass of mercury to be heated, a rather small bunsen burner was selected; and its shape and proportions were chosen so that it would burn properly 25 litres of gas per hour. This was the volume which appeared to be most suitable, and which was already fixed in the light rheometer of the "vérificateur" for the determination of the density.

It was further necessary that this bunsen burner should be capable of burning very different gases, as well as mixtures of gases. After many experiments and trials, the present form was settled upon. Without entering into a detailed description, the following points may be indicated: The injector or nipple, formed by a steatite burner with a well calibrated hole, has an orifice with a diameter of $\frac{8}{10}$-ths of a millimetre. The bunsen burner is 110 mm. long. The head of the burner is likewise formed of a piece of steatite, with a central hole of 8 millimetres, without any metallic gauze. The air entrance consists of a single hole of 7½ mm., the axis of which is exactly at the height of the upper end of the injector or nipple.

It was thought at the outset that it would be possible to observe with the eye with precision the moments at which the column of mercury reached successively 50° C. and 250° C., in order to begin and stop the test at these times. But numerous experiments proved that, even with much attention and a certain amount of practice in testing, such errors of observation occurred that it was not possible to repose full confidence in results made even by a good experimentalist. The passage of the column of mercury to the points indicated was too rapid to permit of the starting and stopping of the stop-clock being made to coincide very exactly with the passage past these two points. Under

these conditions, it was necessary to secure some automatic registration of the passing of the points; and naturally electricity enabled this to be done. It was endeavoured to arrange everything in such a manner that, though the apparatus might be more complicated and more delicate to construct, the experiment would be as simple and as easy to carry out as that for the lighting power and density of the gas. This is believed to have been practically attained, as will be judged from an inspection of the apparatus at work. The electrical arrangement adopted on the thermometer consists of three contacts superposed at convenient distances on the mercurial column.

The first and lowest contact puts one of the poles of the pile in communication with the mercury in a permanent manner. The second contact is placed at the point corresponding to the temperature of 50° C., and is connected to the other pole of the pile; so that at the precise moment when the mercury reaches this contact the current is established, and the stop-clock thereby started. The third contact, placed at the point corresponding to a temperature of 250° C., causes a short-circuit, which effects the instantaneous stoppage of the stop-clock at the moment when the column of mercury has reached this contact. Under these conditions, it is evident that it is sufficient for the maintenance of great sensitiveness and perfect precision in the thermometer, to have the mercurial column of small section only at those points where the two upper contacts are made, in order that at these points the smallest difference of the temperature shall correspond to a distinct change in the height of the mercury. But, between these points, in order to reduce as much as possible the length of the thermometer, and, as a natural consequence, its fragility, some enlargements or bulbs have been made in it which have allowed its length to be readily curtailed to reasonable dimensions.

In order to make the passage of the electric current to the thermometer effect the starting or stopping of the stop-clock, a small electro-magnet, of given resistance, which acts at the moment of the passage of the current on a lever I, which raises the piece N, has been fixed below the stop-clock, which is thereby started. On the other hand, at the moment when the mercury reaches the upper limit H of the thermometer, the short-circuit is established, and the current no longer holds up, through the

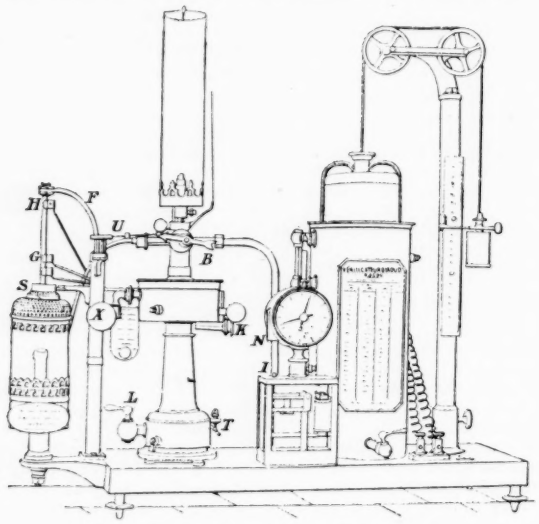


Fig. 1.—The Apparatus Complete.

electro-magnet, the lever I and the piece N, which, falling down, stop the stop-clock. The working is thus very simple and perfectly automatic. The necessity of employing electricity to actuate the stop-clock was a strong inducement to retain this means of transmission for the ordinary tests of illuminating power and density. The result has been obtained by means of a kind of commutator with three arms, placed on the tap B, which directs the gas either to the jet-burner, to the thermometer, or to the gasholder, according to the position of the arrow which serves as the handle of this tap.

The three insulated arms of this commutator receive the three insulated wires from U and allow them to communicate, two by two, through contact-pieces, placed at the bottom of the arms, according to the direction in which the tap is turned. When the arrow is vertical, the electric current is interrupted; by turning the arrow to the left towards the thermometer, the current is sent to the mercurial column; and lastly, by turning the arrow to the right, towards the gasholder, the current starts the stop-clock, which stops again at the moment when the arrow is brought back to the vertical, thereby returning the gas to the jet-burner. It will thus be seen that the tap B which was to be found on the old "vérificateur" has become a four-way instead of a three-way tap.

In order to complete in a few words the description of the apparatus, it remains to be explained that the small column placed at the right of the light-rheometer contains the electric wires, which end at its summit in a little bracket having three pegs, on which are adjusted, by slight friction, the three tubes of the movable piece U. From the latter these wires go into the arms of the commutator of the tap B. The flexibility of the wires ensures the contacts of the commutator in the movements of the tap B. The movability of this piece U was necessary to facilitate setting up and taking down the light-rheometer; so that the column which carries the wires has never to be taken to pieces. The fixed column is cut transversely at the back for a certain length so as to receive the thermometer holder, which is fitted behind the column, and is fixed there by means of the button X. The electrical connections are made between these two halves of the column by insulating plates fixed in each half. The fixed half of the column carries three superposed buttons, and the other half (the lower part of the thermometer holder) carries three small nickel springs corresponding to the three buttons of the fixed part. It will be seen, then, that, by pressing the button X, the thermometer holder is fixed, and the springs which ensure the contacts are stretched. The thermometer holder is shaped like a crutch at its upper part, and is intended always to replace the thermometer precisely in the same position with regard to the bunsen heating burner. This position is determined and fixed by fastenings when the apparatus is calibrated. The thermometer holder is shown (on an enlarged scale) in fig. 2.

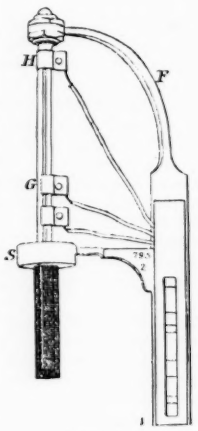


Fig. 2.

It should be added that this calibrating of the bunsen burner and the thermometer is done with such care that two thermometers could be successively placed on the same apparatus and exactly the same result would be obtained, if the gas were the same. Lastly, it may be said that the bunsen burner is surrounded by a large chamber into which the air enters freely through metallic gauze which screens the flame from draughts. On this chamber is a glass chimney, which allows the flame to be examined; and lastly, over it, is a ventilated cover, through which passes the flame for lighting the bunsen burner, when the lever T of the tap of the lighter is turned. The ventilated cover is pierced about at its centre by a hole, in which the ring S of the thermometer holder exactly fits. It must be added that the bulb of the thermometer is surrounded below this ring by metallic gauze suitably selected, which prevents the flame from touching the glass of the thermometer.

All the parts of the "vérificateur" which relate to the calorific test have now been described. It appears unnecessary to repeat here the instructions for working the apparatus for tests of density and illuminating power; as for these tests no change has been made except in regard to the starting and stopping of the stop-clock. This is done automatically merely by the movement of the tap B, but by electrical instead of mechanical means as formerly. When the "vérificateur" has been supplied with the requisite sealing liquids in its various vessels, and the gas has been burning for a few minutes in order to clear out the apparatus thoroughly, the following is the method of conducting a test for calorific power.

The hand of the stop-clock is brought to zero, and the tap B is turned with the arrow pointing towards the thermometer. The lever T of the tap of the lighter is then pressed, in order to light the bunsen burner, which is then kept burning. As soon as the heat raises the column of mercury to the contact G, the electric current starts the stop-clock, which stops again precisely at the moment when the mercury reaches the contact H. It is very important then to bring back the tap B at once to the vertical, in order to put out the bunsen burner, as, if the heat were continued, the expansion of the mercury would cause the thermometer to burst. The seconds hand, by stopping at the moment when the mercury has reached the contact H, indicates the exact time required for attaining the standard difference of temperature. This time is registered by putting the set-hand of the stop-clock exactly above the seconds hand, and then bringing the latter back to zero.

The gasholder having descended pretty nearly to the bottom of its travel, but not having actually grounded, the zero of the vernier of the indicator is made to coincide with the zero of the scale, and gas is passed into the bell for exactly the same time that the first part of the test lasted. To do this, the arrow of the tap B is brought rapidly into the vertical position at the moment when the seconds hand passes under the set-hand of the clock. The number of millimetres shown for the travel of the gasholder corresponds with the volume of gas expended in attaining the difference of temperature t t′; and it is perfectly obvious that the smaller this volume is, the higher will be the calorific power of the gas.

The table of calorific powers given on the next page indicates the number of units of heat corresponding to the volumes, and consequently to the millimetres of the scale of the gasholder. The figures are the result of very numerous tests made by absolutely competent engineers.

TABLE OF CALORIFIC POWER.

Divisions of the Scale. Millimetres.	Calories per Cubic Metre.	B.T.U. per Cubic Foot.
53	5500	618
54	5375	604
55	5250	590
56	5125	576
57	5000	562
58	4875	548
59	4750	534
60	4625	520
61	4500	506
62	4375	491
63	4250	478
64	4125	464
65	4000	449
66	3900	438
67	3800	427
68	3700	416
69	3600	404
70	3500	393
71	3425	385
72	3350	376
73	3275	368
74	3200	360
75	3125	351
76	3000	337
80	2750	309
85	2625	295
90	2500	281

As an example of the results obtained with the apparatus, the experiments in the accompanying table may be quoted.

	Density.	B.T.U. per Cubic Foot.	Calories per Cubic Metre.
First Experiment.—			
Water gas (neat)	0·56	272½	2425
Second Experiment.			
Water gas (neat)	0·585	278	2475
Coal gas (neat)	0·385	604	5375
Mixtures.			
¾ Coal gas, ¼ Water gas	0·437	555	4937
½ Water gas, ½ Coal gas	0·475	464	4125
First Experiment.			
¾ Water gas, ¼ Coal gas	0·520	364	3237
Second Experiment.			
¾ Water gas, ¼ Coal gas	0·50	360	3200

These are figures given by the earliest experiments. The tests will have to be continued, not only in Paris, but in several provincial works—at least, the author hopes so. Till this has been done, no attempt will be made to give a *résumé* of all the experiments made on different gases, and the definite conclusions to which they have led the author. He makes no pretence of having created a new calorimeter, but has endeavoured to meet a special want by contriving a simple and easily managed apparatus which may prove of service to the gas industry for the determination, in a sufficiently precise manner, of the more important qualities of that convenient, but highly complex, product, illuminating gas. It is for gas engineers to say if he has succeeded.

REGISTER OF PATENTS.

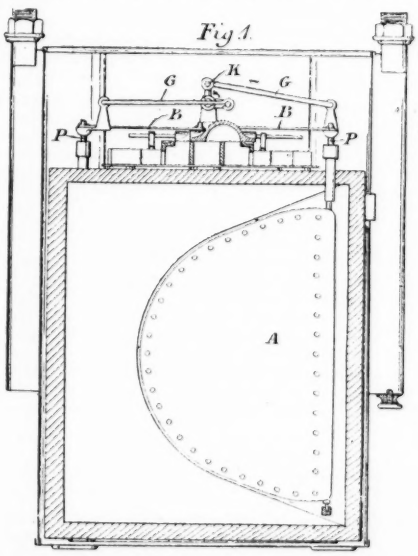
Manufacture of Coal Gas.—Settle, T., and Padfield, W. A., of Exeter. No. 12,552; June 2, 1902.

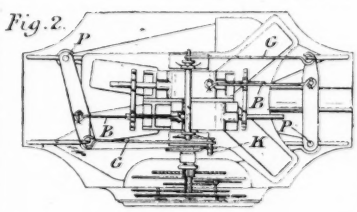
This arrangement of mechanically operated vertical retorts, intended for the continuous carbonization of coal dropped in in small quantities at a time, is the subject of an article appearing elsewhere to-day (see p. 881).

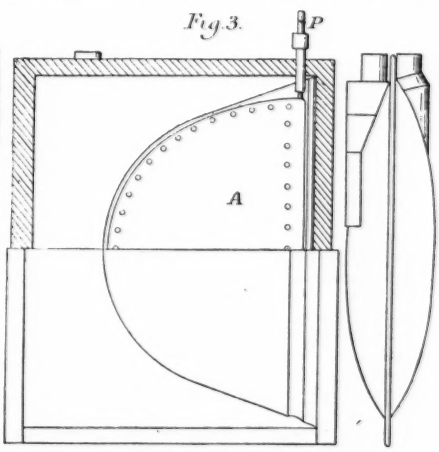
Gas-Meters.—Haas, E., of Mainz, Germany. No. 14,954; July 4, 1902.

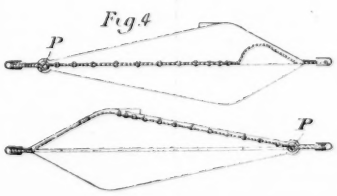
This invention relates to a dry gas-meter in which the registering apparatus and distributing valve are actuated through the medium of a vane having a membrane attached and mounted to vibrate or reciprocate about an axis. The objections heretofore inherent to such meters are said to be obviated by the use of a single vane; the arrangement being such that a fold of the membrane cannot become caught or wedged by the edge of the vane.

Fig. 1 is a sectional front elevation of one form of meter in which one vibrating vane is used in each measuring-chamber. Fig. 2 is a plan of the valve-operating and registering-mechanism. Fig. 3 comprises two views of a measuring-chamber—one view being partly in section, showing the vane only and the membrane. Fig. 4 is a horizontal section showing the relative positions of the two measuring-vessels in one casing, and of the vanes and membranes in the chambers at a certain moment.









A is the vane pivoted to the spindle P carrying a lever arm coupled by a link G to the crank K, and by a link B to the distributing valve—the arrangement being similar for both measuring-chambers of the meter, and the same crank-shaft being common to both. The vane extends beyond the mid-length of the measuring-chamber—the chamber being of the form described—and the membrane attached to the vane and to the chamber as shown.

The vane A presents a large area of surface and great leverage for the pressure of the gas to act upon; so that the power necessary for working the meter is smaller, while variations of pressure do not affect the result. At the same time, by dispensing with the second vane, the formation of sharp and mutually opposed creases in the membrane is avoided.

In fig. 4 is shown the mussel-shaped formation of the measuring-chamber, as also the appearance of the vane and membrane in two different positions. In the one measuring-chamber, the vane is shown in the middle of its swing, with the membrane distended in a comparatively free space; while in the other, the vane is represented at the end of its movement, in which position both the vane and the membrane lie close against the mussel-shaped wall.

Distilling Coal Tar; Applicable also for Other and like Purposes.—Archdale, J., of Miles Platting, Manchester. No. 16,511; July 25, 1902.

This apparatus for the dehydration or distillation of coal tar consists of a "still" or elongated casing, preferably of wrought iron and set in brickwork after the manner of a steam-boiler with a space below for a furnace and flue—as shown.

Fig. 1 (p. 904) is a longitudinal sectional elevation and a plan of the apparatus. Fig. 2 shows the various pipe connections, and a form of condenser for utilizing the heat of the dehydrated tar.

C is the inlet for the tar to be treated, and D the outlet for the dehydrated tar. E is the outlet for the tar vapours; and F are manholes for allowing access to the interior of the casing. The bricks used in the roof of the furnace G are set a gradually increasing distance apart from the door end, so as to prevent the heat reaching the casing too suddenly. H are upstanding flanges or baffles producing the zig-zag passage on the floor of the still. There are also baffle walls I within the furnace flue, so as to produce a zig zag passage under the still. The rear end of the flue passes to a suitable chimney. J is an enclosed tank wherein is a coil of piping K, to the inlet end of which is connected the pipe L, which conveys the hydrated tar from an overhead tank, and to the outlet end of which is connected the pipe M by which the tar is conveyed to, and delivered into, the inlet of the still. With the tar thus admitted, a pipe N is provided dipping into an upstanding pipe O and with the tar flowing through—thereby forming a seal, to prevent the escape of vapour.

As the tar passes into the still, its rate of flow is such that it fills up to the level indicated, but never overflows the flanges H. In passing forward, it follows the zig-zag course produced by the flanges; and "having its traverse thereby greatly extended, meets the heat of the

furnace gradually, and in parting with its moisture does so without a risk of foaming up." The vapour given off, rising to the upper and rear end of the still, passes through the outlet E and through a pipe P into a condenser. The dehydrated tar flows through the outlet D, and through the pipe R direct to the collecting cylinder S, or, by preference, into the tank J, from whence, after giving off its heat to the tar passing

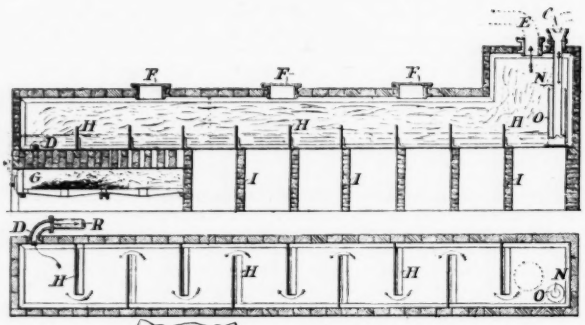


Fig. 1.

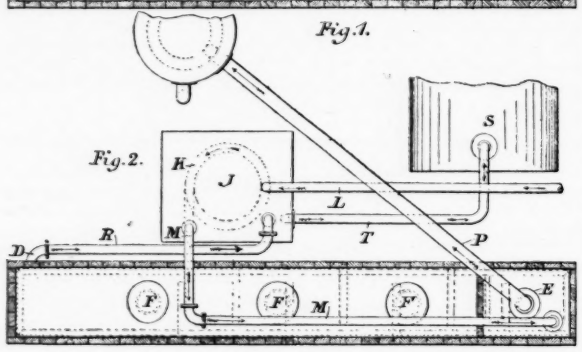


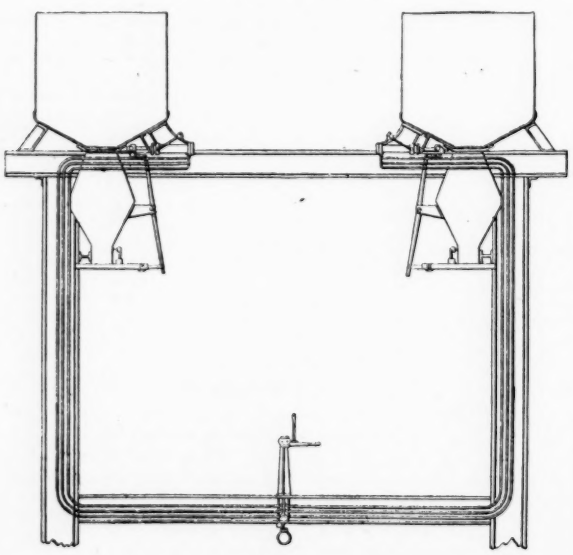
Fig. 2.

through the coil K, it flows through the pipe T to the cylinder S. The end of pipe T extends to the bottom of the tank, and the pipe R is at the top; hence the tank is always full of hot tar.

The length and width of the still will, of course, vary with the amount of tar to be dealt with; but the patentee says that a still 26 feet long by 4 feet wide will usually dehydrate 70 to 80 tons of tar a day.

Manipulating the Slide-Valves of Coal-Storage Hoppers or Measuring Chambers in connection with Inclined Gas-Retorts and Gas-Producers.—Herring, W. R., of Edinburgh. No. 23,892; Nov. 1, 1902.

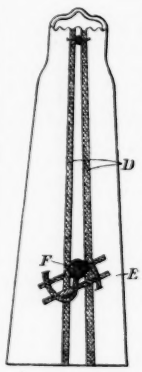
This invention consists mainly in the application of hydraulic power to the working of the slides referred to, instead of manipulating them by hand through compound and other levers—"involving as they do considerable physical labour and greater expense in construction." The illustration given is an elevation of a double setting of retorts



showing the improvements applied to the base of the coal-storing hoppers, and showing the manipulation of the top and bottom slide-valves of the coal-measuring chambers suspended beneath, in connection with inclined gas-retorts. No detailed description is needful, as the arrangement was fully described and illustrated in the "JOURNAL" as recently as April 21, p. 139.

Self-Lighting Incandescent Mantles.—Berthold, R., of New York. No. 1954; Jan. 27, 1903.

In self-lighting mantles as hitherto constructed, the patentee points out, the preliminary and intermediate heaters employed have always been composed of a mixture of several ingredients in varying proportions; but he claims to have discovered that a single substance (rhodium chloride) is the best thing to use by itself as the preliminary heater. In fact, when so used with an igniter of platinum black in the form of a pellet, it is not necessary to have any intermediate heater at all. The igniter may be made of platinum black, mixed with oxides, nitrates, or chlorides of the other metals of the platinum group; but the difficulty is said to be not so much in obtaining a satisfactory igniter, as in getting a satisfactory preliminary heater.



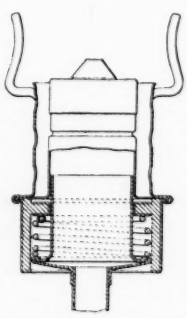
The rhodium chloride is dissolved in pure water, and applied to the mantle with a brush in the form of stripes, lines, or "more or less fanciful decorations." In the illustration, D are stripes of chloride painted on the surface of the mantle so as to lead to the platinum pellet. E is a decorated enlargement of the rhodium chloride stripe. F is a spot of platinum black painted on the enlargement, so as to give more substance to the preliminary heating surface at that point. When the mantle is first put up for use, a flame is to be applied to the top, and the mantle is allowed to burn in the usual way, until all volatile matters are burned away. The mantle is then ready to light itself, and almost immediately after turning on the gas, the rhodium chloride decoration begins to glow, and communicates its heat to the platinum black pellet, which in turn ignites the escaping gas.

Atmospheric Gas-Burners.—Guese, W. E., and Fox, G. A., of Toledo, Ohio, U.S.A. No. 6138; March 17, 1903.

This invention of a "convertible gas supplying and mixing device for gas-burners" is especially adapted for use where both natural and artifical gas are employed as a heating agent for cooking purposes. When, owing to the fact that the pressure of natural gas is so reduced that it cannot be used for cooking purposes, and artifical gas has to be used in its stead, the pipe connections leading to the burners of the gas apparatus need to be arranged as a common carrier of both gases, each of which may be used independently of the other. The proposal is to provide separate orifices for the injection of the gases into the mixer—an orifice of small diameter for the natural gas, and one of larger diameter for the artifical gas.

The device comprises a mixer-chamber having perforations for the admission of air, a plate having coincident perforations adapted to register with the perforations in the mixer-chamber, and having an angular portion cut away. The orifices, of small and large diameter respectively for natural and artificial gas, converge relatively to one another. A plug fitted within the valve-body has a transverse perforation to communicate with either of the orifices therein; while a handle is provided for operating the plug, and a stop arranged upon the plug adapted to engage shoulders upon the valve body so as to insure a movement of the plug handle to engage the cut-away portion of the perforated mixer-plate when the valve is operated to change the orifices.

Incandescent Gas-Burners.—Falk, S., of Farringdon Road, E.C. No. 8158; April 8, 1903.



This invention relates to that class of incandescent gas burners wherein the burner-head is carried upon the gas-tube through the medium of a spring for absorbing vibrations, and wherein the burner-head is weighted to such an extent that its inertia is sufficient to enable it to remain in position notwithstanding the movement of the supporting spring produced by the vibrations of the gas-tube.

The arrangement will be sufficiently appreciated from the engraving. The patentee claims in respect of it: In an incandescent gas-burner the combination of a gas-tube having an enlarged upper part provided with a flange, a head having an enlarged lower part into which a weight is spun, a spring arranged between the gas-tube and the head, and a tube or shield around the upper part of the head.

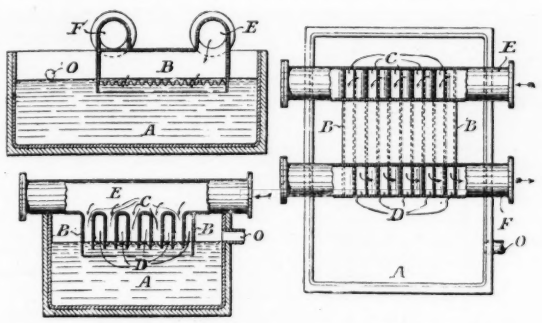
Automatic Ignition of Gas.—Zimmer, E., of Oberschönweide, near Berlin. No. 8248; April 9, 1903.

This device for the automatic ignition of gas is of the class in which the igniter is fixed to a flap arranged on the upper end of the glass chimney in such a manner that after the gas-cock has been turned on, the gas flowing out is caught by the flap and conducted to the igniter, which is thus ignited. After the ignition has taken place, the hot gases of combustion turn the flap on its pivot, and keep it in an upright position as long as the gas-flame burns.

Extracting Ammonia from Gases.—Brunck, R., of Dortmund, Germany. No. 8287; April 9, 1903.

It is known (says the patentee) that, in order to extract the ammonia and its compounds from distillation gases, the latter are either treated with water or with diluted acids. Contrary to this principle, his

process consists in washing the gases with suitable concentrated acids (for instance, with sulphuric acid) at such temperature that the ammonia is directly separated in the form of solid salts or crystals. The salt is baled out in the ordinary fashion, and fresh acid is supplied when needed. The acid must be kept at a temperature of at least 80° to 85° C., so as to prevent the steam contained in the gases from condensing. The temperature may (preferably) be maintained by the hot distillation gases themselves, and is regulated by previously cooling the gases as needed. In order to avoid stoppages in the path of the gases, the separation of the solid salts is preferably effected in open vats only. After leaving the latter, the gases may also be treated in other absorbing apparatus—such as washers, scrubbers, or the like—in order to remove the last traces of ammonia. In this case, only, as much ammonia is to be abso bed by the acid as will cause no salt deposits and stoppages in the closed apparatus. The acid is then run



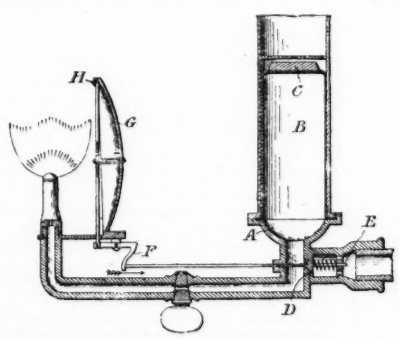
into the open vats in which the salts settle as described. The same treatment may be applied prior to conducting the gases into the vats. When proceeding in this manner, the gases are also previously cooled, as needed, before entering the absorbing apparatus.

A longitudinal section, a transverse section, and a plan are shown of the apparatus suggested. The receiving vat A is filled with concentrated sulphuric acid, in which the vessel B is immersed; the latter being open at the bottom and divided into a number of compartments C and D, the partition-sheets of which are serrated at the open side of the vessel. Across the top of these compartments there are two pipes E and F, the former communicating with the compartments C, and the latter with the compartments D. The gases are first conducted into the chambers C, through the distributing pipe E, and then pass through the acid below the serrated partition-sheets, with the effect of being finely divided. They now enter the chambers D, and are thence led off through the collecting pipe F. The ammonia salt settles on the bottom of the receiving vat, and is baled out at intervals. If necessary, the salt is freed from any tar particles by washing it with a saturated solution of the ammonia salt. The small quantity of tar condensed on the surface of the acid during the process flows off continuously through an aperture O in the vat.

If, according to the one method now in use, the gases are treated with diluted acids, the solution must be strongly concentrated in order to recover the solid salt. In comparison with the other system of washing the gases with water, as almost universally adopted, a still greater advantage is said to be secured by this process, because the ammonia is extracted directly in the shape of solid salts. In the other case, very large quantities of water are required for extracting the ammonia completely. If the ammonia is then fixed to the acid, the solution must be concentrated so as to obtain the ammonia salts, or the ammoniacal liquor has to be subjected to distillation with lime.

Automatically Closing Gas-Burners.—Yerrington, H. W., and Emery, W. H., of Oceanic, N. J., U.S.A. No. 8699; April 16, 1903.

This invention relates to automatic safety gas-burners of the type in which a valve controlled by a thermostat governs the supply of gas to the burner, and is automatically closed when the gas ceases to burn.



As shown, the gas-fitting is provided with an upwardly projecting bowl-shaped extension A, forming the base of a gas-reservoir within which is a flexible gas bag or diaphragm B, closed at its upper end and provided with a weight C, which compresses the bag to force the gas contained therein under pressure to the burner. In the partition D is formed a port or valve seat, behind which is a second partition provided with perforations for the passage of gas from the supply pipe. A valve-stem E is slidably mounted in the partition, and the vertical portion of the pipe below the bowl A is provided with a valve.

The outer end of the valve stem contacts with, but is free from engagement, one arm of a bell-crank lever F, the opposite arm of which is pivoted to a bracket or support clamped upon the burner pipe. The construction is such that when the pivoted or horizontal arm of the bell-crank lever is tilted downward, the vertical arm moves upwardly and rearwardly, and in so doing forces the valve-stem E backward, and moves the valve S away from its seat against the tension of the spring shown, so that when the pressure is removed from the pivoted arm, the spring will restore the valve to its normal position or close it against its seat.

Secured to the bracket in the rear of the burner is a heat retaining shield and reflector G, and secured at its upper end to the reflector at H is a thermostatic expansion bar, which projects at its lower end down through the bracket, and is pivoted to the forward end of the horizontal arm of the bell-crank lever F. This rod, in its expansion and contraction, actuates the lever to force the valve-stem backward so as to open the valve against the tension of the spring and allow the stem to be returned to its normal position by the action of the spring to close the valve.

In operation, the bag B is filled with gas, and the closed end or diaphragm portion is moved, together with the weight C, up against the partition. The stem E is then released, and the valve closed against its seat by the spring. After this has been done, the gas-cock is again opened to allow gas to pass to the burner. The escaping gas, on being ignited, heats and expands the thermostat, and so the lever F is tilted to force back the valve-stem and open the valve; thus allowing gas from the supply pipe to flow freely to the burner. Should the flame be extinguished, however, from any cause, the thermostat will contract, and in so doing will move the lever in the reverse direction, allowing the spring to close the valve and cut off the supply of gas to the burner.

APPLICATIONS FOR LETTERS PATENT.

12,819-20.—Gibbons, W. P. & G. B. A., "Charging horizontal gas-retorts." June 8.
12,831.—Bartlett, J., "Acetylene gas-lamps." June 8.
12,848.—Birkbeck, H.—"Incandescent gas-mantles." A communication from F. J. Cullum. June 8.
13,011.—M'Ewen, T. G., and Curle, J. A., "Manufacture of hydrocarbon gas." June 10.
13,028.—Smith, T. B. & T. E., "Inverted incandescent lamps." June 10.
13,047.—Beaven, E. S., "Treatment of coke." June 10.
13,085.—Kershaw, P. B. W., "Production and storage of hot gases produced by internal combustion." June 11.
13,108.—Graham, M., "Charging gas-retorts." June 11.
13,202.—Jensen, P., "Revivifying gas-purifier waste." A communication from F. Hiorth. June 12.
13,206.—Jas, F., "Producing combustible gases from volatile liquid hydrocarbons." June 12.
13,222.—Jas, F., "Purification of gas." June 12.
13,225.—Harper, J., and Co., Ltd., and Retallack, C., "Gas-cooking apparatus." June 12.
13,295.—Baron, C. E., "Incandescent burner." June 13.
13,301.—Ross, A., "Manufacture of acetylene gas." June 13.

PARLIAMENTARY INTELLIGENCE.

HOUSE OF LORDS.

The following further progress has been made with Bills:—

Bill brought from the Commons, read the first time, and referred to the Examiners: Merthyr Tydfil Urban District Council Bill.

Bills read the first time: Broughty Ferry Gas Provisional Order Bill, Grangemouth Water Order Confirmation Bill.

Bill read a second time: Merthyr Tydfil Urban District Council Bill.

Bills reported: Bournemouth Gas and Water Bill, Commercial Gas Bill, Gas Orders Confirmation Bills (Nos. 1 and 2), Gaslight and Coke Company Bill, Ipswich Gas Bill, Nelson Corporation Bill.

Bills read the third time and passed: Derby Gas Bill, Gas Orders Confirmation Bills (Nos. 1 and 2), Market Drayton Gas Bill, Water Orders Confirmation Bill.

A petition has been presented against the Crystal Palace District Gas Bill by the Beckenham Urban District Council.

The Gas and Water Orders Confirmation Bill, the Market Drayton Gas Bill, and the Walker and Wallsend Union Gas Bill have been referred to a Select Committee, consisting of the Earl of Belmore (Chairman), the Earl of Malmesbury, the Earl of Powis, the Duke of Wellington, and Lord Manners; to meet to-day.

HOUSE OF COMMONS.

The following further progress has been made with Bills:—

Bills brought from the Lords, read the first time, and referred to the Examiners: Gas Orders Confirmation Bills (Nos. 1 and 2), North-Western Electricity and Power Gas Bill.

Lords Bills read a second time and committed: British Gaslight Company (Norwich) Bill, Chard Corporation Gas and Electricity Bill, Torquay Corporation Water Bill.

Bills reported: Belfast Water Bill [Lords], Broughty Ferry Gas Provisional Order Bill, Scunthorpe Urban District Water Bill [Lords], Shepshed Urban District Gas Bill [Lords].

Bills read the third time and passed: Broughty Ferry Gas Provisional Order Bill, Grangemouth Water Order Confirmation Bill, Harrogate Water Bill [Lords], Merthyr Tydfil Urban District Council Bill, Rickmansworth Gas Bill [Lords].

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

The Mantle Licence Question.

SIR,—I notice, in the issue of the "JOURNAL" last week (p. 742), your remarks on Sir George Livesey's report to the guarantors of the fund instituted to contest the Welsbach patent. It is, of course, well known that the action in question was settled "out of Court;" and there is no doubt that the thanks of the gas lighting trade and the public are due to Sir George for the timely and determined assistance which he lent, by his action and powerful influence, in order to free incandescent mantles in this country from an oppressive monopoly, and to cheapen them for the public.

I cannot, however, now agree with Sir George Livesey's advice that makers here or abroad should support the Welsbach Company, by paying the 3s. per gross royalty under the Welsbach patent of 1893, as, in my opinion, there is absolutely no justification for taxing the trade, and indirectly the public, with any royalty at all. I will give my reasons.

It is well understood that if a licence is granted or accepted under a patent, the licensee agrees to pay a royalty for some privilege which the licensor may give him. The Welsbach Company, however, while granting licences to some, allow others to sell unlicensed mantles without taking any steps whatever to prevent this; and therefore I maintain they give the licensee absolutely no protection or benefit. In other words, while the Welsbach Company agree to accept royalties from such people as are willing to pay them, they allow others who do not agree to pay royalties to sell their mantles without let or hindrance.

I will go further, and boldly assert what may not perhaps be apparent to Sir George Livesey—viz., that, while the Welsbach Company accept royalties from such people as are willing to pay them, *they allow a certain number of makers and importers to sell their mantles under a licence without enforcing the payment of a royalty.* It will be obvious from this statement that firms who pay a royalty, or would be willing to pay, are thereby put to a most serious and unfair disadvantage, and cannot possibly compete with their licensed mantles—paying 3s. per gross royalty—against other licensed mantles paying no royalty at all.

Sir George Livesey will further forgive me if I express surprise that, after the disclosures which have been made at the recent trial in Vienna, he should still advocate the payment of a royalty to the Welsbach Company, and thereby increase the cost of mantles to the consumer. Would it not be better for Sir George to frankly admit—

(1) That the Welsbach Company had much the best of the bargain he concluded with them last year, as it must be clear to him now that they could never have gone into Court.

(2) That new facts have since been brought to light, which justify him (Sir George Livesey) rather to advise gas managers and the trade in general *not* to pay a tax any longer on mantles, but to still further cheapen them for the consumer.

In conclusion, would it not be fairer on the part of the Welsbach Company to boldly avow that they cannot uphold their 1893 patent, and to free the incandescent mantle trade from the uncertainty under which the public and a certain section of the trade still labour?

In my opinion, the time has arrived when incandescent mantles should be as free "*from monopoly and patent protection*" as any other article. In using these words, I am only echoing the remarks of the Chairman of the Welsbach Company in his speech at the general meeting of the Company on May 5 last.

June 19, 1903. ONE INTERESTED IN THE GAS INDUSTRY.

The Proposed Affiliation of District Associations with the Institution of Gas Engineers.

SIR,—In connection with the above question, which is about to occupy the attention of a Committee of the Institution of Gas Engineers, the enclosed extract from my address as President of the British Association of Gas Managers in 1879 may possibly be of interest to some of your younger readers.

Barkston Ash, near Tadcaster, June 18, 1903. W. J. WARNER.

[ENCLOSURE.]

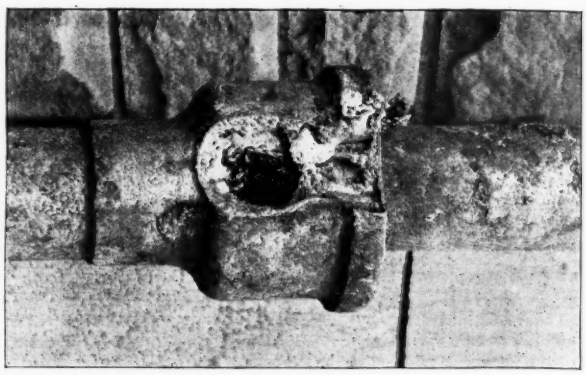
Is our organization adapted to develop to the fullest the collective knowledge and experience of the profession, and make available for the common good the opportunities for observation which the members possess? If this is not so, we do not take that high position as a profession which we should occupy, and fail, to this extent, in the application of science to the manufacturing arts. That we do occupy such a position, I think, cannot be maintained. This, however, is no reflection upon the Association. By its action it was felt that its advantages required supplementing by local knowledge and local experience. Naturally, then, these local societies are the outgrowth of the other, and we have here, roughly shaped, perhaps, a model of an Association of fairer proportions, in which could be combined the general and the particular, theory and practice—facts from observation on which to base general laws, which would form a perfect whole—an Association to elevate the profession to the position of which it is worthy.

The . . . Associations are all capable of having their several districts better defined than they are at present; indeed, the whole of the United Kingdom should be divided geologically, by the respective coalfields. The late Mr. James Paterson gives five important coal districts. . . Our raw material would then naturally divide the work of observation and inquiry, for the purposes of classification and comparison. The British and local Associations—or, if you will permit me to call them so, the head and its branches—would find their work equally well defined. The head would determine the inquiry and formulary, and the branches would make the observations and returns. The whole would then be classified and compared.

To become associated with the local societies, it will be necessary to alter our constitution; but there will be no difficulty, I think, in this, as the matter will rest with ourselves. We are nearly all local members now. Such changes need not deprive the local or branch Associations of freedom of action in other matters than those prescribed by or affecting the whole of those associated. The local presidents would doubtless be chairmen of committees of the branches, and members of the Councils of those associated for associated work. I need not pursue the matter further than this, to shadow forth the practical character of the changes suggested, and to show that by such we shall be brought more into harmony with the local Associations. Such changes, I feel assured, are necessary to develop to the fullest our resources, and will rapidly and materially raise us as a profession.

Stray Electric Currents and Gas-Mains.

SIR,—The enclosed is a print of a 2-inch gas main which has been fused by leakage of electricity from a cable supplying current to the tramway system. The main was laid in close proximity to one of the section boxes, a cable in which had by some means come in contact with the box; and the current, instead of returning by the earth wire



to the tram-rail, fused the main as shown in the photograph. The following is an account of the affair given by one of our local papers: "A mishap of a serious nature occurred at the section box belonging to the electric cars on the Bolton Road section. It appears that in the box near the Britannia Inn, a wire had, by vibration, worked a hole in the gas-main, and upon the gas coming in contact with the wire it ignited. The fire was soon extinguished, and the necessary repairs were promptly done. The affair caused a delay for some time."

Darwen, June 20, 1903. A. H. SMITH.

Gas "Arc" Lamps.

SIR,—I am afraid we must admit the disadvantage Mr. A. R. Burch complains of in his letter in your last issue, as regards high-power gas *versus* electric lamps. From some recent experiments carried out, it does not seem possible at present to produce the intense amount of light required with a shorter (natural) draught tube than the one now in use of the Lucas lamp type. The design of the pendant for these burners is not quite "a thing of beauty," leaving much to be desired. A more pleasing pattern would be welcome, although its production is easier said than done, from the long length of stem required. I saw in the City a few days ago a smaller type of pendant (I believe an American make) about 2 feet long, of good design, and well finished, giving a light of 300 candles, suitable for shop entrances or low-pitched rooms; and I am trying to find out the agent for the sale of them.

The drawback to burners of this kind is the great amount of heat evolved close to the ceiling, compared with the old style of lighting, making it a necessity to provide ventilation at the time of fixing the pendants, if they are to remain popular and permanent. The following will show the effect of good ventilation. About six weeks ago I was in a drawing-room lighted by a 5-light chandelier, and noticed that the ceiling was almost as white as it was when last cleaned, about seven years since. On inquiring the reason, I found it was due to a large ventilator having been fixed over the pendant, and another at the side of the chimney.

Reigate, June 20, 1903. E. STANLEY PIKE.

Differential Prices for Gas.

SIR,—I have read in the "JOURNAL" the remarks made from time to time on the subject of selling gas at a low price for heating, cooking, motive power, &c.; and I should like to give you my idea thereon.

The cost of gas is almost the same, whether it be used for lighting, cooking, heating, &c.; and yet not exactly the same, because lighting gas is consumed for only a few hours in the daytime, and then the expense for gasholders, pipes, &c., per 1000 cubic feet is higher for lighting gas. But the difference is rather small as a percentage of the total cost. Then why should cooking or heating gas be sold cheaper than lighting gas? Some people say, when the charge is less, the consumption is greater and the profit may be larger. But that is the case not only for heating gas but also for lighting gas; and there is no reason for any difference between the price of both.

On the other hand, the cost of summer gas is less than that of winter gas. The plant is erected according to the largest daily winter consumption. If the summer consumption augments, the working expenditure increases; but the expense for interest, sinking fund, &c., does not, and the total cost per 1000 cubic feet decreases. It would, therefore, be reasonable to charge a lower price when the total cost is less. The summer consumption could increase without any addition to the cost of the plant, and the profit would also increase. Therefore, instead of charging only one price, as you do generally in England, or two different prices for lighting and other purposes (with separate meters), I should advise two different prices—one for summer and the other for winter, with only one meter for each consumer.

June 18, 1903. PARISIAN.

LEGAL INTELLIGENCE.

THE WREXHAM GAS EXPLOSION CASE.

In last week's "JOURNAL" (p. 812), there was reported a case heard at the Wrexham County Court arising out of an explosion of gas which occurred at the public hall in the town early in December. The Public Hall Company sued the Gas Company for £2 4s. 6d., damage done by the explosion; but the Judge (Sir Horatio Lloyd), after taking time to consider the matter, found in favour of the defendants.

In delivering his reserved judgment, his Honour said the action was only for a small amount; but he took it the principle involved was an important one for both parties. It was an action by the Wrexham Public Hall Company against the Gas Company for negligence, resulting in an explosion of gas. The facts were very simple, and were not disputed so far as he understood. The public hall was supplied with gas by the Gas Company; and it was conveyed into the building by means of service-pipes from the main, which ran under the street alongside the hall. The main-pipe had been laid for a very considerable number of years, and so far had been satisfactory. Some time ago, an escape of gas occurred in one of the rooms at the public hall, which resulted in some explosions, and the damage for which the present action was brought. The Gas Company were immediately communicated with by telephone; and after awhile, it was discovered that the cause of the mischief was that the main-pipe had been broken just outside the hall. The way in which it was broken was quite clear—it was done obviously by some passing weight over the surface of the road; and there being frost at the time, and the surface of the road being frost-bound, the gas, instead of escaping in the ordinary way through the surface, escaped as was usual in these cases, along the pipes, entered the building, and caused the explosions. The action was brought against the Gas Company for negligence. It was objected by the Gas Company that the word "negligently" was not used in the plaint. This was a technical objection which he should feel obliged to dismiss, because it was obvious that the only ground for which the action was brought was founded upon negligence. He should therefore amend the plaint by inserting the word "negligently." This brought them to the greater question as to whether there really was any negligence. The only negligence that could be alleged was that the pipes were laid at an insufficient depth. In fact, they were laid 18 inches from the surface of the ground; and the question was whether this was a sufficient depth, having regard to the state of the traffic upon the road at about the time the pipes were laid. It was not a question of whether they were sufficient for the traffic of to-day. They were laid twenty or thirty years ago; and the question was whether they were sufficient for the traffic at that time. Heavy steam-rollers had since been introduced; and it was quite obvious that when a gas company under statutory powers had laid pipes under streets at a sufficient depth for the then state of the traffic, or the traffic which might be reasonably contemplated, they had done their duty, and they were not bound to take up the streets to lay fresh pipes because somebody else chose to bring in a vehicle that weighed 50 tons—he used that weight for the sake of argument. They could not be perpetually altering their plans to meet the new inventions that occurred almost daily. Those who introduced these heavy vehicles on to the roads, did so at their own risk. Therefore the question was not whether the depth of 18 inches was enough now, but whether it was sufficient thirty years ago for the then traffic, and for all that might be reasonably contemplated. A similar question arose at Denbigh some three years ago, when the Water Company brought an action against the Corporation. The steam-roller belonging to the Corporation had broken pipes in several streets. A great number of expert witnesses were called in on either side; and it was quite clear that 18 inches was enough for the ordinary traffic of the time when these pipes were laid, but that now it was not safe to lay them at a less depth than 2 ft. 6 in. The witnesses agreed that a less depth than 18 inches was insufficient under any circumstances. That he was right in the principle that the depth must be in reference to the time when the pipes were laid, was borne out by a judgment of the High Court, and since then by two cases in the Appeal Court in Ireland. The present case, curiously enough, came to what was practically the dividing line—18 inches; but as he had already held, as a result of the expert evidence at Denbigh, that 18 inches was sufficient, and that anything less was insufficient, he must adhere to that decision. At Denbigh, the depths he condemned were 14 to 16 inches. Where the pipes were laid 18 inches below the surface, he held that they were sufficient for the former traffic of the roads, and therefore there was no neglect. He felt bound to apply that to the present case. He found there was no negligence here, having regard to the previous use of the road, and that the mischief was caused by the extra weight upon the road. Judgment would be for the defendants.

Birmingham Gas Coal Contracts.—It is said the Birmingham Corporation Gas Committee have placed contracts for 483,000 tons of coal at prices equivalent to a reduction of 6d. per ton as compared with those paid last year; and, further, it is understood that the quality of coal contracted for is rather superior. If this is so, the department will stand to save over £12,000 on their coal bill this year.

Reductions in Price.—The Warrington Gas Committee, acting on the suggestion made by Mr. W. S. Haddock in his annual report on the gas-works (*ante*, p. 814) that a reduction in price would lead to an increased consumption, have decided to lower the charge for gas by 1d. per 1000 cubic feet. The Kidsgrove Gas Company will reduce the price of gas, as from the 1st prox., by 3d. per 1000 cubic feet to all consumers. At Mansfield, as from the end of the present quarter, the price of gas is to be reduced 2d. per 1000 cubic feet to all consumers. The rates will then be 2s. 6d., 2s. 8d., and 2s. 10d. per 1000 feet, according to consumption.

MISCELLANEOUS NEWS.

EXAMINATIONS IN GAS MANUFACTURE.

The Pass List.

The Superintendent of the Department of Technology of the City and Guilds of London Institute (Sir Philip Magnus) has issued the Pass List in connection with the last examinations in "Gas Manufacture." The following are the names of the successful candidates:—

HONOURS GRADE.

First Class.

Allen, P. T.	Clarry, R. G.	Larkin, F. S.	Shaw, Frederic G.
Astbury, Ernest	Crossley, S.	Mead, H. S.	Shenton, G. H.
Blackadder, T. T.	Duncan, G. J.	Nuttall, L. W.	Upton, W.
Bottomley, J. W.	Heald, W. L.	Peace, W.	Warburton, G.
Brooke, T.	Herris, G.	Royle, H. M.	White, J. H. W.
Chew, J. H.	Hunter, R. W.	Scholefield, F.	Wilkinson, H.
Clark, G. J.	Jennings, F. R.		

Second Class.

Baillie, W.	Buxton, J. W.	Herman, W. J.	Robinson, F. H.
Bean, E.	Chalmers, R. B.	Keillor, J.	Stevens, J. R.
Beaumont, T. H.	Coe, J. J.	Loveridge, C.	Townsley, J.
Brooke, R. M.	Critchley, T.	Lowe, T. G.	Warren, W. H.
Brown, R. H.	Cunnington, W.	MacKean, J. J.	Webb, R. N.
Burgess, H.	Fligg, G. W.	M'Call, W.	Wedd, F. H.
Burton, H.	Gibson, J. W.	M'Pherson, C.	Whitaker, L. V.
Butterfield, H.	Hazell, H. D.	Robertshaw, W. L.	Wilson, H.

ORDINARY GRADE.

First Class.

Berry, J.	Game, J. W.	Hornby, J. T.	Smith, J. M. L.
Brown, J. T.	Garsea, E.	Hunter, D.	Snelgrove, L. M.
Buckler, A. G.	Gill, G. M.	Kaye, F. H.	Stevenson, G. S.
Canning, T. F.	Gillett, E.	Littlewood, H.	Stephenson, J.
Carr, H. R.	Griffin, C.	Lumb, H. D.	Stones, E. E.
Chree, R. H.	Griffin, J.	M'Crae, J. P.	Thomson, A.
Clark, F. W.	Hammerton, T. W. T.	M'Donald, R. B.	Tooms, D. W.
Clark, P. B.		Mackay. A.	Twigg, W.
Cloudslay, J. L.	Hardy, W. A. G.	Matthews, F. A.	Walmsley, G.
Clough, F.	Harston, V. E.	Mosedale, H.	Wardell, R.
Cooke, D.	Head, W. G.	Newsome, J. E.	Wilkinson, E.
Crow, H. W.	Heathcote, A. W.	Parrish, P.	Woodfine, H. J.
Dean, W. E.	Hepburn, J.	Roper, C. T. B.	Woodcock, T. H.
Fielden, W.	Higham, H.	Rule, H.	Wynne, J. C.
Foster, E.	Holmes, G. E.	Severn, E. M.	

Second Class.

Barker, W. H.	Geer, L. J.	Kellock, A.	Taylor, B.
Barrow, J.	Harrisson, A. J.	Kermeth, G. T.	Taylor, H. C.
Biggs, H. A.	Hawkyard, W.	M'Nab, P.	Taylor, R. E.
Brushfield, N. W.	Hayes, J. W.	Newsome, M.	Thomas, A.
Burton, J. A. H.	Henry, A. H.	Nield, T. H.	Todhunter, H.
Bywater, J. H.	Hill, E.	Norris, H. C.	Toulson, J. W.
Chapman, F. W.	Hogg, W. T.	Pearce, F. J.	Vince, E. P.
Clapham, W. A.	Hornby, T.	Pye, B. A.	Walker, D.
Davies, J. H.	Houston, J. G.	Randall, L.	Walker, J. C.
Darrah, J.	Hufton, W. C.	Roper, J. W.	White, J. H.
Dunphy, A. L.	Ibbotson, S. W.	Smith, G. P.	Whiteley, G. G.
Fenner, R. L.	Jeffrey, D.	Sugg, P. H.	Wilson, F.
Free, G.	Jennings, A.	Sutton, R.	Winslow, G.

THE FATAL GASHOLDER ACCIDENT AT KENNINGTON.

The crowded state of our columns last week prevented more than the brief recording of the Jury's verdict in the inquest on the bodies of the two men (Aspinall Shaw and Thomas Morrell) who were fatally injured on the 26th ult. through falling from the top of a gasholder 50 feet high at the Kennington Oval works of the South Metropolitan Gas Company. Both men were in the service of Messrs. Clayton, Sons, and Co., of Leeds. At the opening of the inquiry, evidence of identification and medical testimony were given; and the inquest was then adjourned for a fortnight.

When the proceedings were resumed last Wednesday week, the first witness called was Mr. Vanse Ashwell, Manager to Messrs. Clayton. He said he was present at the time of the accident, superintending the alterations and repairs which his firm were carrying out. The deceased were fixing an iron guide upright to the existing standard on the outside frame of the gasholder, and were performing their work in a wrought-iron cage suspended from a framework on the top of the standard by a wire rope, which went round a pulley at the bottom, attached to a crab. The accident happened when the men were being lowered from a height of between 40 and 50 feet. The crab was manipulated by manual labour. Witness was close behind watching the lowering operation. Suddenly he noticed that the barrel of the crab was running free, and was not under the control of the handles, with the result that the wire rope ran off, and the cage, with the two men in it, fell a distance of about 45 feet. The barrel ran free owing to the shaft of the crab getting out of gear. The deceased man Shaw had had quite a dozen years' experience in this work; and he arranged the crab which caused the accident. There were other crabs on the job at the time which could have been used if Shaw had not been satisfied with that particular one; but he made no complaint whatever as to the crab not being suitable for the job. He had never known an accident of this kind to occur before. In cross-examination, witness said he had had seventeen years' experience of this work, and considered that the crane used, though it did not possess a brake, was a proper one for

the operations. It was, of course, possible for a hand-crane to be fitted with a brake; but in their work they thought it safer to trust to the handles. Mr. Seymour (H.M. Inspector of Factories): How many crabs had you on the works? Witness: About six. Mr. Seymour: How many are not fitted with brakes? Witness: All the other crabs on the works are fitted with brakes; but the brakes are not used at all. Mr. Seymour: Do you mean to say that five crabs out of six on this job are fitted with brakes, and that the brakes serve no earthly purpose at all? Witness: They serve no earthly purpose at all. A Juryman: Nonsense. By the Jury: If this crab had been fitted with a brake, he did not believe the accident would have been prevented.

George Ashwell said that Messrs. Clayton had crabs in their posession with brakes; but the brakes were never used. J. T. Young, a labourer in the employ of the Gas Company, stated that the deceased had been pulled up and lowered several times the same morning without accident; and Philip Hilson, foreman at the works, said he supposed the deceased must have jumped out of the cage, as one fell in front of it and the other came down alongside. The latter witness pointed out that this particular crab belonged to the Contractors; the Gas Company had no crabs without brakes. If there had been a brake to this crab, and it had been applied when the wheel ran free, the cage could have been prevented from falling. Leonard Hartley said he was Inspector for Messrs. Clayton, and had had 25 years' experience in constructing and repairing gasholders. He had never used a crab with a brake. Previous to being sent to Kennington, the crab in question was thoroughly overhauled. The Coroner: If it was examined, I cannot understand how the defect was not observed. Witness added that he had seen the demonstration with the crab which had during the proceedings been made outside the Court, and would still say that the crab was in good condition. Mr. Patey (who appeared for the family of the deceased man Morrell): Though you do not use the brakes for lowering, there can be no objection to having them to prevent accidents? Witness: No.

Mr. A. F. Browne, the Engineer in charge of the works, said he was not present at the time of the accident; but there was no doubt in his mind that the crab ran free because the upper pawl or clutch was not properly in position. If it had been in position, it would have been impossible for the shaft to have worked out of gear. The Coroner: Would you pass this crab as safe? Witness: No. The accident was due to the pawl controlling the drum fouling the upper pawl or clutch as it was being thrown back. The possibility of such a thing constitutes a defect in the crab. Allow me to say I can take no responsibility for this crab, either personally or on behalf of the South Metropolitan Gas Company. The Coroner: What is your view with regard to brakes? Witness: I am bound to say that I am largely in agreement with the last witness. The nature of the work has to be taken into consideration; and, in my opinion, it would be dangerous to lower on the brake. When there is a brake, men may be tempted to use it in order to facilitate the work. The Coroner: Would it have been possible, if there had been a brake, to have prevented the accident by applying it? Witness: If there had been a brake, and the men adjacent had put it in operation at once, it is conceivable that the sudden shock would have thrown the men out of the cage. I have grave doubts as to whether the existence of a brake would have prevented this regrettable loss of life. By Mr. Patey: A brake was undoubtedly a good "stand-by." He would certainly advise the use of crabs with brakes; but a great many were being sold and used without them.

The Coroner, in summing up, said that, while he did not think there had been gross negligence, there certainly ought to have been a more judicious examination of the crab before it was used; and at the time it was in operation the working of the more important parts should have been more carefully observed by the men actually using it. After a few minutes' consultation, the Jury returned a verdict of "Accidental death due to a faulty crab."

DUNDEE CORPORATION GAS AND ELECTRICITY SUPPLY.

Reduction in the Price of Gas.

The annual accounts of the Dundee Corporation Gas Department, a summary of which has already been published in the "JOURNAL" (*ante*, p. 681), were submitted to the Town Council last Wednesday.

Treasurer RITCHIE said the estimated revenue in the Gas Department was £117,327, and the actual £122,060; showing a surplus of £4733. The estimated expenditure for the year, including the surplus, was £117,327, and the actual, including the debit balance and parliamentary charges, amounted to £121,378; leaving a debit balance of £4051. The total income was £122,060, and their total expenditure £121,378; leaving a surplus of £682. The figures for the Electricity Department were as follows: The estimated revenue, balance included, was £25,914; the actual, £24,041—being £1873 under the estimate. The estimated expenditure was £25,667; the actual, £24,041, or £1625 below the estimate. The total income, including the balance, was £24,259, and the expenditure £24,047; leaving a surplus of £212. With regard to the estimate for the current year, they anticipated a make of 700 million cubic feet of gas instead of 665 millions; being an increase of 35 millions. In considering the income to be derived from the sale of gas, they had debited themselves with the average percentage of unaccounted-for gas, which reduced the quantity for sale as given in the estimate. The estimated revenue from all sources, including the balance from last year, after allowing for a reduction of 6d. per 1000 cubic feet on gas, as well as a differential rate of 3d. on gas consumed by engines when supplied through a separate meter, amounted to £113,289, and the expenditure, as detailed in the estimate, to £111,847—leaving a surplus of £1442. As regarded the Electricity Department, the total estimated income, including balance, was £27,221, and the expenditure £27,120; showing an estimated surplus of £101.

GAS AND WATER COMPANIES' STOCK AND SHARE LIST.

Referred to on p. 874.

Issue.	Share.	When ex-Dividend.	Dividend or Interest & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.	GAS COMPANIES.			£ s. d.
590,000	10	April 17	10½	Alliance & Dublin 10 p.c.	19–20	..	5 5 0
170,000	10	,,	7½	Do. 7 p.c.	13–14	..	5 7 2
900,000	5	May 14	6½	Bombay, Ltd. . . .	5⅞–6	..	5 8 4
140,000	5	,,	6½	Do. New, £4 paid	4–4⅛	..	5 15 7
300,000	Stk.	Feb. 26	12	Brentford Consolidated	240–245	..	4 18 0
586,700	,,	,,	9	Do. New . . .	178–183	..	4 18 4
50,000	,,	,,	5	Do. 5 p.c. Pref. .	131–136	..	3 13 6
206,250	,,	June 11	4	Do. 4 p.c. Deb. .	108–111*	..	3 12 1
220,000	Stk.	Mar. 12	10	Brighton & Hove Orig.	212–217	..	4 19 1
246,320	,,	,,	7	Do. A. Ord. Stk. .	151–156	..	4 19 4
460,000	20	Mar. 31	10	British.	39½–40½	..	4 18 9
103,000	Stk.	Mar. 12	6	Bromley, 5 p.c. "A" .	118–123	..	4 17 7
165,700	,,	,,	4½	Do. 3½ p.c. "B".	90–95	..	4 14 9
500,000	10	May 14	7	Buenos Ayres (New) Ltd.	11–11⅛	–¼	6 1 9
250,000	Stk.	Dec. 30	4	Do. 4 p.c. Deb.	94–96	..	4 3 4
150,000	20	Mar. 12	8½	Cagliari, Ltd. . . .	23–25	..	6 12 0
100,000	10	June 11	10	Cape Town & Dis., Ltd.	14½–15½*	..	6 9 0
50,000	50	May 2	6	Do. 6 p.c. 1st Mort.	52–54	..	5 11 1
1,375,000	Stk.	Feb. 26	5	Commercial 4 p.c. Stk.	103–106	..	4 14 4
503,750	,,	,,	4¾	Do. 3½ p.c. ,,	98–101	–1	4 14 1
407,817	,,	June 11	3	Do. 3 p.c. Deb.,,	87–90*	..	3 6 8
800,000	Stk.	June 11	8	Continental Union, Ltd.	125–130*	..	6 3 1
200,000	,,	,,	7	Do. 7 p.c. Pref.	137–142*	..	4 18 7
575,000	Stk.	Feb. 26	5⅛	Crystal Palace Ord. 5 p.c.	113–118	..	4 10 2
60,000	,,	,,	5	Do. 5 p.c. Pref. .	120–125	..	4 0 0
106,158	,,	Jan. 15	5	Do. 5 p.c. Deb. Stk.	137–140	..	3 11 5
486,090	10	Jan. 29	10½	European, Ltd. . . .	18–19	..	5 10 6
354,060	10	,,	10½	Do. £7 10s. paid	13–14	..	5 12 6
15,243,200	Stk.	Feb. 12	4 7/16	Gas- 4 p.c. Ord. . .	85–87	+1	5 1 2
2,600,000	,,	,,	3½	light 3½ p.c. max. .	85–87	..	4 0 6
3,799,735	,,	,,	4	and 4 p.c. Con. Pref.	108–110	..	3 12 9
4,193,975	,,	June 11	3	Coke 3 p.c. Con. Deb.	86–88*	..	3 8 2
238,500	Stk.	Mar. 12	5	Hastings & St. L. 3½ p.c.	90–95	..	5 5 3
70,000	10	June 11	8	Hongkong & China, Ltd.	15–16*	..	5 0 0
3,800,000	Stk.	May 14	10	Imperial Continental .	205–208	+1	4 16 1
473,600	Stk.	Feb. 12	3½	Do. 3½ p.c. Deb. Red.	100–103	..	3 8 0
165,242	Stk.	Mar. 12	6	Lea Bridge Ord. 5 p.c.	115–120	..	5 0 0
561,000	Stk.	Feb. 26	10	Liverpool United A .	218–220	+1	4 10 11
718,100	,,	,,	7	Do. do. B .	166–168	..	4 3 4
306,083	,,	Dec. 31	4	Do. do. Deb. Stk.	112–114	..	3 10 2
75,000	5	June 11	5	Malta & Medn., Ltd. .	4¼–4⅜	..	5 5 3
560,000	100	April 1	5	Met. of 5 p.c. Deb.	103–107	..	4 13 6
250,000	100	,,	4½	Melbourne 4½ p.c. Deb.	102–104	..	4 6 7
541,920	20	June 11	3½	Monte Video, Ltd. . .	9½–10⅜	..	6 13 4
1,515,892	Stk.	Feb 20	4½	Newc'tle & G'tesh d Con.	104–105	..	4 5 9
376,855	Stk.	Jan. 2	3½	Do. 3½ p.c. Deb.	96–97	–½	3 12 2
300,000	Stk.	May 14	8	Oriental, Ltd. . . .	14⅝–14⅝	..	5 10 4
600,000	5	Mar. 31	7	Ottoman, Ltd. . . .	6–7	..	5 0 0
					* Ex div.		

Issue.	Share.	When ex-Dividend.	Dividend or Interest & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p.c.	GAS COMPANIES.			£ s. d.
205,005	Stk.	Jan. 15	6½	Ply'mth & St'house 5 p.c	127–132	..	4 12 9
851,070	10	April 30	7	River Plate Ord. . .	11–11¼	–¼	6 1 9
300,000	Stk.	Dec. 30	4	Do. 4 p.c. Deb..	56–58	+1	4 1 8
250,000	10	April 17	8	San Paulo, Ltd.. . .	1½–12½	–⅛	6 8 0
135,000	Stk.	Mar. 12	10	Sheffield A	239–241	..	4 3 0
209,984	,,	,,	10	Do. B	237–240	..	4 3 4
523,498	,,	,,	10	Do. C	237–239	..	4 3 8
103,235	Stk.	Mar. 31	5	Shrewsbury Ord. 5 p.c.	111–114	..	4 7 9
6,000,000	Stk.	Feb. 12	5⅓	South Met., 4 p.c. Ord.	119–122	..	4 7 4
1,180,000	,,	Jan. 15	3	Do. 3 p.c. Deb. . .	50–52	..	3 5 3
380,940	Stk.	May 14	5	Southampton Ord. . .	105–110	..	4 10 11
87,950	,,	Jan. 15	4	Do. 4 p.c. Deb.	103–106	..	3 15 6
120,000	Stk.	Feb. 26	6	Tottenham and Edmonton A. 5 p.c. B. 3½ p.c.	117–122	..	4 13 4
300,520	,,	,,	4½		56–59	..	4 10 11
182,380	10	June 11	8	Tuscan, Ltd.. . . .	8–9*	..	8 17 10
149,000	10	Jan. 2	5	Do. 5 p.c. Deb. Red.	99–101	..	4 19 0
730,872	Stk.	Mar. 12	5	West Ham, 5 p.c. Ord.	95–100	..	5 0 0
				WATER COMPANIES.			
780,776	Stk.	Dec. 30	11⅓	Chelsea, Ord. . . .	325–335	..	3 8 8
150,000	,,	,,	5	Do. 5 p.c. Pref. .	148–153	..	3 5 4
160,000	,,	,,	4½	Do. 4½ p.c. Pref. '75	130–140	..	3 4 4
175,785	,,	Mar. 31	4½	Do. 4½ p.c. Deb. .	137–142	..	3 3 5
1,720,560	Stk.	Mar. 31	8	East London, Ord.. .	245–250	–1	3 4 0
654,740	,,	June 11	4½	Do. 4½ p.c. Deb. .	138–143*	..	3 2 11
1,282,943	,,	,,	3	Do. 3 p.c. Deb. .	94–96*	..	3 2 6
700,000	50	June 11	10	Grand Junction 10 p.c. max.. 4 p.c. Deb..	140–143*	..	3 9 11
310,000	Stk.	Mar. 31	4		123–128	..	3 2 6
708,000	Stk.	Feb. 26	10½	Kent	300–310	..	3 7 9
160,000	,,	,,	7	Do. New, 7 p.c. max..	200–210	..	3 6 8
1,043,800	100	Dec. 30	11	Lambeth, 10 p.c. max..	320–330	..	3 6 8
406,200	100	,,	8⅓	Do. 7½ p.c. max..	225–235	..	3 12 4
350,000	Stk.	Mar. 31	4	Do. 4 p.c. Deb..	122–127	..	3 3 0
500,000	100	Feb. 12	12 5/10	New River, New Shares	430–440	..	2 18 2
1,000,000	Stk.	Jan. 29	4	Do. 4 p.c. Deb..	123–128	..	3 2 6
902,300	Stk.	June 11	7⅛	South-wark and 7½ p.c. max. 5 p.c. Pref.	273–278*	–4	2 14 0
126 500	100	,,	7½		210–220*	..	3 8 2
489,200	Stk.	,,	5		148–153*	..	3 5 4
1,019,585	,,	Mar. 31	4	Vauxhall 4 p.c. A Deb.	122–127	..	3 3 0
1,155,066	Stk.	June 11	10	West Middlesex. . .	303–308*	..	3 4 11
200,000	,,	,,	4½	Do. 4½ p.c. Deb. .	136–141*	..	3 3 10
200,000	,,	Mar. 12	3	Do. 3 p.c. Deb. .	95–97	..	3 1 10
					* Ex div.		

Both departments were now under new management, which they trusted and believed would be beneficial so far as the economical working of the Gas and Electricity Departments were concerned, and would consequently operate for the cheap production of gas and electricity—a consummation they all desired. He wished to say how much the Council were indebted to Mr. Donald, the Assistant-Engineer, for the great care and ability he displayed during the vacancy. Under his supervision, the greater part of the work for the winter was put in progress, and the result showed how carefully and skilfully he managed affairs. In Mr. Yuill they had a thorough and practical Engineer, determined, as far as he was concerned, to have the gas-works in perfect order, so that cheaper gas might be produced. He was convinced that by another year, if nothing unforeseen arose, they would have a further reduction in the price of gas. Whenever they had reduced the charge to such a rate as would be no barrier to its free consumption, they ought to maintain that price, even though they could afford to further reduce it, and apply the surplus towards the reduction of capital account. He proposed that the price of gas be charged as follows: To the consumers in Dundee, 3s. per 1000 feet; in Invergowrie, 4s.; in Downfield, 4s.; Harbour lamps, 3s.; Esplanade lamps, 3s.; Downfield lamps, 4s.; also that a differential rate of 3d. per 1000 cubic feet be allowed on gas consumed by engines, through separate meters—all subject to a discount of 5 per cent. if paid within 28 days after the accounts are rendered; to the Dundee Town Council (Police Administration), for gas supplied to the public lamps, 2s. 10d. per 1000 cubic feet without discount; and for gas consumed through automatic meters, 3s. 4d. per 1000 cubic feet net. He also proposed that the price of electric energy to ordinary consumers, otherwise than by agreement and for motor power, per quarter, should be as follows: For any amount up to 20 units, 6s. 8d.; for each unit above 20 units, 4d.; and that all consumers who take above 10,000 units be charged 3d. per unit, subject in all cases to a discount at the rate of 5 per cent. if paid within 28 days. He also moved that the public lamps be charged at the rate of £15 each for those burning the whole night, and £7 10s. each for those burning part of the night, net; and that electrical energy for motor power be charged: For 40 units, or under, per quarter, a minimum of 6s. 8d.; above 40 units per quarter, 2d. per unit if taken through a separate meter, but if not taken through a separate meter, the ordinary rate of 4d. per unit, subject in all cases to 5 per cent. discount if paid within 28 days.

Mr. BALLINGALL seconded the motion.

Mr. STEVENSON said the satisfactory way in which the work of the Gas Department had been carried on during the year reflected the greatest credit on Mr. Yuill, his staff, and the employees generally. He pointed out that they paid for capital charges 6d. per 1000 cubic feet more than Glasgow, and that this outlay went on in spite of all management. He drew attention to the fact that in the accounts there was an item of £9336, portion of the sinking fund allocated as depreciation for the year ending April last. He disputed their power to allocate the sinking fund to depreciation, as it was for paying off borrowed money and for redeeming annuities; and he moved, as an amendment, that the words "portion of sinking fund allocated as depreciation for year to 30th April, 1903, £9336," be left out.

Mr. MATHERS did not see why users of gas-engines should get their supplies at 2s. 9d., while the ordinary consumer paid 3s. per 1000 cubic feet; and he moved that both rates be fixed at 3s.

Treasurer RITCHIE having replied to the discussion, the motion was carried against that of Mr. Mathers; Mr. Stevenson's amendment being ruled incompetent.

Mr. STEVENSON protested, and entered his dissent.

WIDNES CORPORATION GAS AND WATER SUPPLY.

At the last Meeting of the Widnes Town Council—the MAYOR (Alderman Gossage) in the chair—the report presented by the Gas and Water Committee contained a recommendation, already briefly noticed in the "JOURNAL," that the price of gas should be reduced as follows: To ordinary consumers inside the borough of 3 million cubic feet and upwards per annum, from 1s. 3d. to 1s. 2d. per 1000 cubic feet net; to consumers of less than 3 millions per annum, from 1s. 5d. to 1s. 4d. net; and to consumers for motive power purposes, from 1s. 1d. to 1s. net. (It was explained that "net" meant payment within one month from the end of the preceding quarter, otherwise the price was increased by 2d. per 1000 cubic feet); the quantity of gas supplied to slot-meter consumers inside the borough to be increased from 38 to 40 cubic feet for 1d. To ordinary consumers outside the borough, a reduction of 1d. per 1000 cubic feet net—*i.e.*, payment within one month from the end of the preceding quarter, otherwise the price to be raised by 3d. per 1000 cubic feet; the quantity of gas supplied to slot-meter consumers in two districts to be increased by 2 cubic feet, and in one district by 1 cubic foot, for 1d. The report also set forth that the number of ordinary gas cooking-stoves on hire was 627, and that there were 651 slot cookers; making a total of 1278, compared with 1214 twelve months ago. The number of houses fitted up under the slot-meter system was 3745.

Alderman TIMMIS, in moving the adoption of the report, said the net profits realized during the past year were £3750 on the gas account, and £1630 on the water account. It was not within the province of his Committee to say what should be done with these profits, and consequently in a later stage of the proceedings they would hear what the Finance Committee proposed to do. The Gas Committee had suggested that the sum of £1630 should be devoted to the purposes of public lighting, and the remainder of the profit used for liquidating a floating account against the Committee for mains, gas-stoves, meters, and similar things, for which otherwise money would have to be borrowed. This suggestion was, he was pleased to say, accepted by the Finance Committee. Proceeding, he stated that during the

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PREPAYMENT METER.

twelve months ending the 25th of March the total quantity of gas delivered was 267 million cubic feet—an increase to the extent of 6·5 per cent. upon the previous year. The quantity of water pumped was 983 million gallons—an increase of 10 per cent. The extra quantity of gas delivered since March compared with the corresponding period of last year had been 10 per cent.; and they had every reason to believe that the current twelve months would be as prosperous as the last. The number of consumers had augmented to 2355 ordinary and 3745 on the slot-meter system; making a total of 6000 roughly. Included in this were 1278 who had cooking-stoves. He did not know whether this would lead the Council to think the Committee would be justified in anticipating the profits they were likely to realize. They had made £3700 on the gas last year, and already there was, as he had said, 10 per cent. increase in the consumption; and they had every reason to suppose that they would have at least equal profit at the end of the year. The Committee thought, therefore, that they were justified in making the reduction set out on the *agenda*. Suppose they only had £3700 profit altogether, and at the end of the year devoted £1700 to public lighting, it would leave £2000. The proposed reduction of 1d. all round would absorb £1000, even extending to the outside districts the same privilege; and this he thought was a gracious thing to do. They would thus have £1000 of the calculated profit for contingencies. The earnings during the past year had chiefly resulted in economies in administration; and this was a very satisfactory statement to bring forward. The large earning had been due to good management. In their proposed reduction, they had dealt with the slot-meter consumers liberally, and had increased the quantity to be supplied for 1d. from 38 to 40 cubic feet, which represented a reduction of about 1¼d. per 1000 feet consumed on this system. Another point was with regard to the quality of the gas. The illuminating standard specified in the Act was 18 candles. But the tests made during the past year showed that the average quality had been 18·9-candle power; so that the quality required legally had been well maintained. This was, he thought, a most important point to those who used gas for cooking, heating, and motive power, since any reduction in the illuminating quality of the gas meant also a lowering of its heating value. The change in price brought the cost of gas for motive power down to 1s. per 1000 cubic feet. A great deal had been said about "producer" gas and its use for power purposes; but Widnes gas at 1s. per 1000 cubic feet, and of the present quality, was 25 per cent. cheaper than any producer gas that had up to the present been put upon the market. Producer gas, as made by the Mond process, was 3d. per 1000 cubic feet; but its calorific value was only one-fifth that of Widnes gas. It therefore required 1s. 3d. worth of Mond gas to do the same work as 1000 cubic feet of ordinary gas as supplied in Widnes for 1s. This was a very important fact, and one upon which they might well proudly dilate when talking with their friends who had the misfortune to live out of Widnes. Compared with electricity, it was found that current would have to be supplied at ¼d. per unit to compare in cost with Widnes gas for power purposes.

Mr. G. DAVIES, in seconding the motion, pointed out that there would be no lowering of the illuminating power of the gas with the reduction in price.

After a few remarks, in which the Chairman and members of the Committee and the Engineer (Mr. Isaac Carr, M.Inst.C.E.) were complimented on the results they had achieved,

Alderman QUINN proposed that the best thanks of the Council should be accorded to them, as well as to the Engineer's assistants.

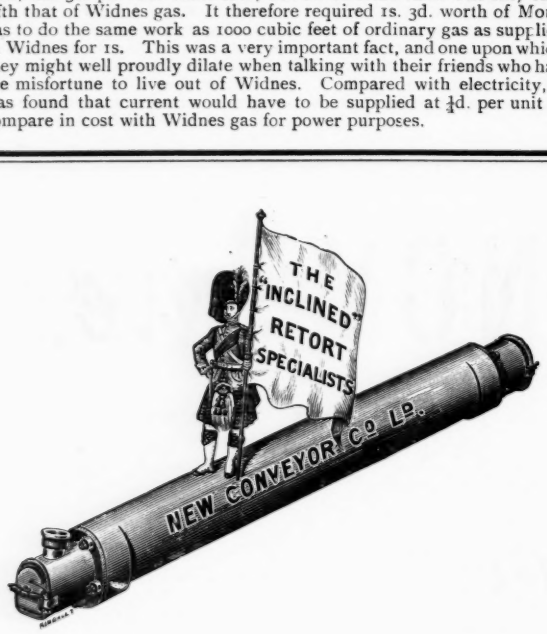
The report and Alderman Quinn's proposition were adopted.

Alderman TIMMIS thanked the Council for their vote, and emphasized the point that the saving which had been effected had been in management, and amounted to 2½d. per 1000 cubic feet of gas. He expressed his pleasure at the fact that the Engineer and his assistants had been included in the vote.

MARKET HARBOROUGH GAS SUPPLY.

The Past Year's Working.

At the last Meeting of the Market Harborough District Council, the report of the Manager and Secretary of the Gas Department (Mr. A. T. Harris) for the year ending March 31 was submitted. In the course thereof, he stated that the expenditure on revenue account had been £5322, while the net receipts were £7694; leaving a gross profit of £2372, compared with £2081 in the year 1901-2, or an increase of £291. As the interest on loans, the repayment of the principal, and one year's proportion of the Parliamentary expenses connected with the purchase of the works absorbed £2254, there was left a net profit of £117. Mr. Harris went on to say that the net receipts from private consumers, after deducting discounts, last year were £5276, against £5272—an increase of £4, notwithstanding a diminution in the quantity sold of 319,200 cubic feet. This was accounted for by the better price realized; increased sales to smaller and additional consumers more than counterbalancing the larger quantity sold at a lower price to one large consumer, whose consumption during the year decreased by 2,138,000 cubic feet. After allowing for this, an increased quantity of 1,818,800 cubic feet was sold to other consumers, of which 826,400 cubic feet was due to the extended use of prepayment meters. The revenue from residual products amounted to £1623, compared with £1538—an increase of £85, of which £73 was due to sulphate of ammonia. The net receipts for residuals were equal to 56 01 per cent. of the cost of coal; being the highest percentage during Mr. Harris's services under the Council. He concluded by saying that, taken as a whole, last year had been the most satisfactory of the four years the works had been in the possession of the Council. With an increased consumption, combined with a reasonable price for coal and residual products being maintained, he thought the financial results should in the future be even more successful.



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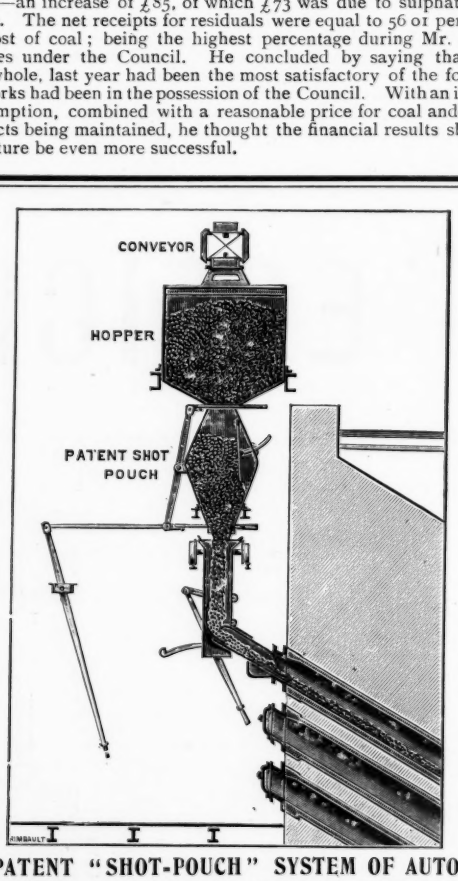

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The working statement showed that the quantity of gas made was 40,810,000 cubic feet, of which 31,284,100 cubic feet was sold to ordinary consumers, 2,300,400 cubic feet through prepayment meters, and 3,134,200 cubic feet for public lighting; making together 36,718,700 cubic feet, or 89·97 per cent. of the make. The rest of the gas was used on the works and in the offices, or was unaccounted for. The quantity of coal carbonized was 3776 tons, from each of which 10,807 cubic feet of gas was produced, and 9724 cubic feet sold. The coke produced was 2407 tons, being 12¾ cwt. per ton of coal; the tar, 44,645 gallons, or 11¾ gallons per ton; and the sulphate made, 39 tons 17¾ cwt., or 1 ton 1⅛ cwt. per 100 tons of coal.

The adoption of the report was moved by the Chairman of the Gas Committee (Mr. G. G. Gardiner), who expressed his pleasure at the past year having been a record one, as regarded both the general and the financial results. Having dealt in detail with the various matters mentioned in the report, he went on to say, with regard to the continued working of the new regenerator settings, that the past year had shown once more the wisdom of the Council in adopting them, as the sale of coke again represented a saving of 570 tons as compared with 1900 with the old plant; being equal to a saving of £300. The works had now passed the experimental stage, so far as the Council were concerned. Though the Committee had not yet seen their way to make a grant from the Gas Department in relief of the rates given a period of reasonable prices for coal, and the satisfactory sale of residuals, the time might soon come when they would consider the question of a slight reduction in the price of gas, or the allocation of some of the profits in relief of the rates of the district. The Chairman of the Council (Mr. J. L. Douglass) said the best thanks of the Council and the ratepayers were due to the Manager for the more than efficient manner in which he did his work. They had in him a most excellent servant. The report was adopted.

LEIGH GAS AND WATER SUPPLY.

In the "JOURNAL" a fortnight ago, we noticed briefly the results of the past year's working of the Gas and Water Departments of the Leigh Corporation, as given in the report of the Engineer and Manager (Mr. James Gibson). The following are some additional particulars taken from that source. The quantity of coal and cannel carbonized was 13,802 tons, or 950 tons (6·44 per cent.) less than in the preceding twelve months; the bulk of gas sent out being 149,666,000 cubic feet, or 5,784,000 cubic feet (4·03 per cent.) more than before. The quantity accounted for was 143,710,900 cubic feet, against 138,001,855 cubic feet in 1901-2—an increase of 5,679,045 cubic feet, or 4·11 per cent. The make of gas per ton of coal and cannel carbonized was 10,800 cubic feet; and the quantity sold was 10,269 cubic feet—both results being the highest on record during the past ten years. The high make per ton accounts for the decrease in the bulk of coal and cannel used; and it justifies the Committee in their purchase of screened coal. The wages account in the carbonizing department was 0·329d. per 1000 cubic feet of gas sold less than in the year 1901-2; but Mr. Gibson thinks this could be reduced if the storage capacity were increased. At present it is 560,000 cubic feet, whereas the maximum day's make is 800,000 cubic feet. This is a matter upon which he purposes presenting a special report. The capital actually invested in the works amounts to £159,695, against £153,849 last year; being at the rate of £11 11s. 4·91d. per ton of coal carbonized, compared with £10 8s. 6·97d. The interest and sinking fund payments require now £9920, against £6804; being at the rate of 16·799d., compared with 12·015d. per 1000 cubic feet of gas sold. The result of the year's working is a loss of £1285, compared with one of £3471 for the year 1901-2. While the increase in the consumption of gas last year was 4·28 per cent., the capital charges went up to the extent of 45·8 per cent. This mainly accounts for the net deficit in the balance-sheet. With regard to the water undertaking, 155,112,000 gallons of water were paid for, producing £7401, or an average of 11·45d. per 1000 gallons. The net profit was £522, compared with £427 before. This is Mr. Gibson's first annual report; and, on the whole, it may be regarded as satisfactory.

SMETHWICK CORPORATION GAS SUPPLY.

A Successful Year's Trading.

At the Meeting of the Smethwick Town Council on Tuesday, the annual report on the working of the Gas Department was submitted by the Secretary (Mr. W. J. Sturges). It showed that during the year further capital amounting to £14,862 had been raised; and that the net amount of loan indebtedness at the end of the financial year stood at £203,251, compared with £189,182 at the close of 1901-2. The capital outlay had increased to the extent of £10,671. There was a satisfactory augmentation in the sales of gas to the extent of 7·4 per cent. The increase in the prepayment class of consumers was 36 per cent. The sales to ordinary consumers, at 2s. 9d. per 1000 cubic feet, had gone up 3½ per cent., and those at 2s. 7d. per 1000 feet 6½ per cent.; while the large consumers, at 2s. 4d., had fallen off 3¾ per cent., due possibly to lower trade consumption. On the other hand, the gas sold for power and manufacturing purposes had increased 32½ per cent. The total income from the sale of gas was £1619 in excess of the previous year; and the total quantity of gas sold was 320,314,400 cubic feet, or 22,032,700 cubic feet more. The unaccounted-for gas amounted to 5·31 per cent. of the quantity sent out, compared with 6·25 per cent. in the year 1901-2. There was a considerable improvement in the returns from residual products. The income from all sources was £50,667, compared with £47,565 before. The expenditure was £37,390, or a decrease of £1132. The charges connected with the manufacture of gas amounted to £30,036—a decrease of £213. The

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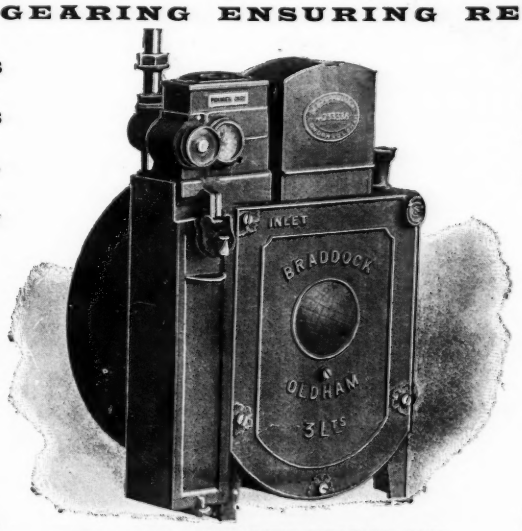

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average cost was 1s. 9·319d. per 1000 cubic feet, against 1s. 10·810d. for the previous year; being equal to a saving of £2100 on the total quantity of gas produced. The average price of coal worked out to 14s. 11·17d. per ton, compared with 15s. 9·77d.; and the quantity of gas made per ton was 11,294 cubic feet—an increase of 328 cubic feet, which reflected great credit upon the Gas Manager (Mr. Vincent Hughes). The gross profit on the year's trading was £13,276, or 9·948d. per 1000 cubic feet of gas sold, compared with £9042, or 7·275d. for the preceding year. The net profit was £3490. After contributing £2000 to the district rate account, there remained a balance of £1490 to be carried to the depreciation and suspense fund accounts. The Chairman of the Gas Committee (Mr. J. Stones), in moving the adoption of the report, remarked that the year had been an exceedingly satisfactory one. The profits had increased, partly owing to the enormous consumption of gas, and also to the higher price realized for residuals. The Committee had received many requests to reduce the price of gas, especially for power purposes; but they were unable to comply with them. They had, however, decided to fix free of charge a number of incandescent burners in place of the ordinary ones supplied in houses occupied by prepayment meter consumers. The report was adopted.

ELECTRIC LIGHTING NOTE.

Proposed Scheme for Kingstown.

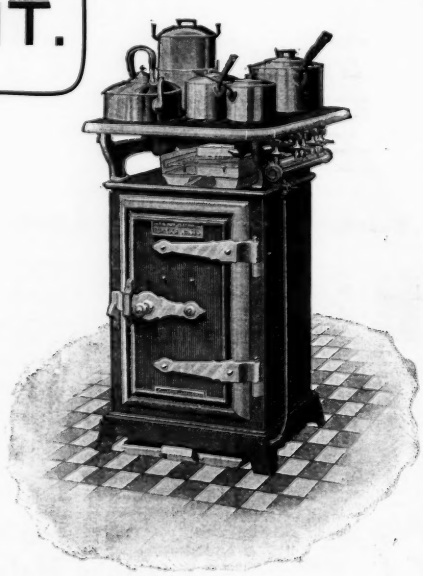
The Urban District Council of Kingstown do not appear to be greatly struck with the advantages of the scheme which their Electric Lighting Committee submitted to them in a report presented at their meeting last Tuesday. A draft contract had been sent in by Edmondson's Electric Lighting Corporation, under which they would carry out an installation on a schedule of prices to be agreed upon; the Council borrowing the necessary capital, which would include the full amount the Council have paid, or are liable to pay, on account of the scheme. The Company would then take a 25 years' lease of the undertaking, and work it on their own account; paying the Council as rent half-yearly such sums as would be required to pay the interest and sinking fund on the borrowed capital. The Council would have the right to re-enter at the expiration of 14 years—taking possession of the works, and relieving the Company of all further payment; or they could adopt this course at the end of seven or ten years on paying a fixed amount of compensation. The adoption of the report having been proposed, Mr. Barrett moved, as an amendment, that it should be referred back to the Committee; contending that the proposed agreement was entirely in favour of Edmondson's, and that if adopted it would prove disastrous. It was proposed to charge the private consumers 7d. per unit, and supply the current for power purposes at 2½d., and for public lighting at ¼d. more. This would mean that the private consumer would be paying for the public lighting. He advocated the use of incandescent gas, and cited Cork as an instance of this system being adopted to the exclusion of the electric light. Mr. Molloy, on the other hand, defended this illuminant on the ground of its being cheaper, according to the figures given by Mr. Bradley, the Chief Engineer of the City of Westminster. After some discussion, the amendment was carried by 11 votes to 3; so we shall now see what the Committee will do next.

SALES OF STOCKS AND SHARES.

At the Mart, Tokenhouse Yard, E.C., last Tuesday, Mr. Alfred Richards offered for sale, by order of Directors and others, stocks and shares in several gas and water companies. The first lots consisted of a new issue of ordinary consolidated stock of the West Ham Gas Company, ranking for a standard dividend of 5 per cent. per annum, subject to the sliding-scale, and entitled to a dividend at this rate; and the price realized was £101 per £100 of stock. A new issue of £5000 of 5 per cent. ordinary stock of the South Essex Water-Works Company, entitled to 4 per cent. dividend, was then submitted for competition, and was all disposed of at £102 and £102 10s. per £100. Some 4 per cent. perpetual debenture stock of the Tonbridge Gas Company was sold at £100 to £101. A small parcel of consolidated "A" ordinary stock of the Croydon Gas Company fetched £300 per £100 of stock. Ten £50 fully paid "C" shares in the Portsea Island Gas Company, ranking for a standard dividend of 9 per cent. (the last having been at the rate of 12 per cent.), realized £122 and £123 each; and £60 of 4 per cent. perpetual debenture stock, £102 per £100. The last lot consisted of some £5 fully paid ordinary shares in the Malta and Mediterranean Gas Company, Limited, which fetched £4 10s. apiece. Next day, Messrs. Fox and Bousfield sold some Colney Hatch Gas Company's £10 original shares at £19; and some Aldeburgh Gas Company's £10 shares at £16. In accordance with the announcement made in our advertisement columns, the fourth sale of shares in the Portsmouth Water Company, under their Order of last year, took place last Tuesday; Messrs. Penney and Clark, of Southsea, being the auctioneers. The shares were sold in lots of five, each share being of the face value of £5, and bearing 5 per cent. interest. The result of the sale was that 18 lots were sold at £6 12s. 6d. per share, 84 lots at £6 10s. per share, and 298 lots at £6 7s. 6d. per share; the total amount realized being £12,825—a premium of £2825, compared with £3002 at the third sale, £2683 2s. 6d. at the second, and £2746 5s. at the first. At Rothesay House, Newmarket, recently, Mr. O. E. Griffiths sold £830 of stock of the Newmarket Gas Company, in lots of £50 each, at prices ranging from £73 to £76, and a lot of £30 at £46. On the same occasion, £70 of the Gas Company's stock fetched £106; and a £100 debenture of the Water Company, £101.

The East Ardsley Gas Company have placed the order with Messrs. R. Dempster and Sons, Limited, of Elland, for new carbonizing plant, on their patent regenerator system.

POPULAR WITH PEER AND PEASANT.



. . The . .

"Eureka."

IMPROVED WATER SUPPLY FOR EAST LONDON.

Opening of New Reservoirs.

On Monday last week, two new reservoirs, which have been for some time in course of construction at Walthamstow for the East London Water-Works Company, were formally opened by Mrs. Lockwood, the wife of the Chairman (Colonel Lockwood, M.P.). In the year 1897, the Company obtained an Act sanctioning the above-named work, and also the erection of a pumping-station, the formation of certain aqueducts, and the diversion of a tributary of the River Lea; the most important portions of the scheme being, of course, those just finished. The new reservoirs, which cover an area of 164¾ acres, and have a combined capacity of 1198 million gallons, have been named the "Banbury" and the "Lockwood," in compliment to the Chairman and his predecessor; and they will about double the Company's storage capacity. Brick-lined aqueducts, upwards of 1½ miles in length, have been constructed, as well as inlet and outlet works for both reservoirs; while the river diversion extends to 1¾ miles. In the new pumping-station, which is situated close to the Banbury reservoir, pumps have been erected, which are capable of lifting 105 million gallons of water a day. The chief difficulties in carrying out the works were in connection with the puddle trench of the Lockwood reservoir, where it was found necessary to carry the excavations down to 60 feet below the ground level. The length of the banks is upwards of three miles. The northern extremity of the new works adjoins the Chingford pumping-station; and the water here enters a double culvert, and also the new aqueduct, 36 feet wide, which is capable of carrying 180 million gallons daily. This aqueduct extends for half-a-mile to the new pumping-station, where there are the three centrifugal engines to lift water from the aqueduct into the Banbury reservoir. From this aqueduct a similar channel, 20 feet wide, with a carrying capacity of 80 million gallons per day, leads to the High Maynard reservoir, a mile farther south; passing on the way the inlet chamber to the new reservoirs. Three cast-iron pipes lead vertically down for 50 feet from the inlet chamber to a tunnel 577 yards long, connecting the two reservoirs. The tunnel has a valve tower at either end (one in each reservoir); and there are also valves on the vertical inlet chamber pipes, so that water can be directed from one reservoir to the other, or from the aqueduct to either reservoir, or from either reservoir to the aqueduct, as the water level will allow. At the south end of the Lockwood reservoir is another valve tower, at the commencement of an outlet tunnel leading to the Capper Mills aqueduct, whence the water can pass to the Lea Bridge station. The Company have now twelve storage reservoirs, having an aggregate water area of 479 acres, and a shore-line of more than 15 miles. The new works, which were designed by the Company's Chief Engineer—Mr. W. B. Bryan, M.Inst.C.E.—have been carried out by Messrs. S. Pearson and Son; Mr. H. Ashley (who is now the Resident Engineer of the Portsmouth Water Company) being the Assistant, and Mr. C. F. Marsh the Resident Engineer.

By invitation of the Directors, a small party of visitors travelled from London to attend the opening ceremony. Among those present were Colonel and Mrs. Lockwood, Messrs. Helme and Wigram (Directors), Mr. Bryan, and the Secretary (Mr. I. A. Crookenden). On reaching Tottenham, they were driven to the Chingford pumping-station and the intake from the River Lea. After these works had been inspected, the party were conveyed to the new pumping-station, at which water was pumped into the Banbury and Lockwood reservoirs. On arrival at the south end of the latter reservoir, Mrs. Lockwood performed the opening ceremony.

At the subsequent luncheon, at which Colonel Lockwood presided, the toast of "The King" was followed by a short address by the Chairman, who referred in terms of congratulation to the completion of the works, which, he said, had been carried out regardless of expense, and to the entire satisfaction of those who had advised the Directors. For the first time in many years, the East London Company could now say that they were ahead of the requirements of their customers. He trusted that it might be a long time before it would be necessary to use the water that would be stored in the new reservoirs; but if a drought ever came, they would be found of the greatest advantage by the new Water Authority. Having warmly acknowledged the services of the Chief Engineer, and also those of the Secretary, the Chairman said he regretted very much that this was the last great work which the Company had to complete before they resigned their trust; and he only hoped that the Water Board might always be found equal to its responsibilities. The Company had been subject to a good deal of criticism; but he was a great believer in criticism as applied to public bodies. Criticism had also been addressed to other governing bodies; and he hoped that they would be able to pass through it with as much satisfaction to themselves as the East London Water Company had done. He had nothing to say with regard to the policy in accordance with which it had been decided to hand over the undertakings of the Water Companies in the Metropolis to a new body, and it was not befitting that he should enter into any polemics on such an occasion. As a good citizen, who believed that whatever was done by Parliament must be right, he would endeavour to forward in every possible manner the difficult work which the new Board would have before them. Though it was quite true that they awaited with considerable anxiety the award of the distinguished men who had been called to arbitrate upon their undertaking, they would, at all events, have the satisfaction of knowing that they were handing over to the authority works which would do them credit, and which, as they believed, would suffice for the wants of London for some time to come.

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CURRENT SALES OF GAS PRODUCTS.

LIVERPOOL, *June* 20.

Sulphate of Ammonia.

There has been a well sustained demand for prompt delivery, and, although re-sales are reported to have been made at a decline, makers have been able to obtain last week's currencies. The closing quotations are £12 17s. 6d. per ton f.o.b. Liverpool, and £13 per ton f.o.b. Leith. The Continent being practically off the market, the quotation f.o.b. Hull remains £12 13s. 9d. per ton. The quotations in the forward position are £12 15s. per ton for July-September, and £12 12s. 6d. per ton for October-March delivery f.o.b. Leith; but these prices are above buyers' views, and no further important business is reported.

Nitrate of Soda.

This article is very firm in all positions, and the attitude of holders seems to be justified by the strong statistical situation. Spot prices remain at 9s. 4½d. and 9s. 7½d. per cwt. for ordinary and refined qualities respectively.

LONDON, *June* 20.

Tar Products.

The markets, as a rule, remain in the same position; and there is not very much business doing. Pitch is quiet, especially for forward delivery. There is rather more offering in the North; makers being very desirous to place their output for twelve months forward if possible. Further business has been done in 50 90 per cent. benzol at 7d.; while it is reported that 8¼d. was accepted for 90 per cent. at an outport for prompt shipment. Crude carbolic remains quiet. Further business has been done at 1s. 6d. for July-September delivery; but consumers are not so very eager to purchase. In creosote, there is no fresh business to report. Prices remain stationary; but there is rather more offering in the North. Business in anthracene is still very quiet; but there is a fair inquiry for forward delivery. Consumers are quite willing to pay 2d. per unit over next year; but makers will not entertain this price. As regards naphthalene, there is rather more doing in refined; while for crude there is a better demand for July-December delivery. Solvent and toluol are both very depressed. An offer of 6½d. for the latter article was, however, declined by London makers. Tar continues to rule very high; and it is difficult to see how distillers can hope to make a profit on the prices recently paid, unless there is a considerable advance in the value of products.

The average values during the week were: Tar, 23s. 6d. to 32s. 6d. Pitch, London, 56s. to 56s. 6d.; east coast, 53s. to 53s. 6d.; west coast, 52s. to 52s. 6d. Benzol, 90 per cent., 8¼d. to 8¾d.; 50-90 per cent., 7d. Toluol, 7d. Crude naphtha, 3d.; solvent naphtha, 7½d. to 8¼d.; heavy naphtha, 9d. Creosote, London, 1¾d. to 1⅞d.; North, 1⅛d. to 1¼d. Heavy oils, 2d. Carbolic acid, 60 per cent., 1s. 6d. Refined naphthalene, £5 to £9; salts, 21s. 6d. to 23s. Anthracene, "A" quality, 1¾d. to 1⅛d.; "B" quality, 1d. nominal.

Sulphate of Ammonia.

The market continues steady, with a fairly good demand, especially from London, for prompt delivery. Beckton still quote £12 17s. 6d. for July-September; while another London Gas Company have actually realized this price, on their own special terms, for June shipment, and now ask £13 for prompt. In Hull, the market has been slightly weaker—£12 10s. having been accepted; but makers as a rule ask £12 11s. 3d. to £12 12s. 6d. for June shipment. Business is, however, very restricted at this port. As regards Leith, there is not much business to report for prompt shipment; but a few sales appear to have taken place at £12 17s. 6d., although as a rule makers ask £13. There is a good deal of forward business reported at from £12 5s. to £12 10s. for October-March. The general tone of the market is firm, especially as regards London.

NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

The Dundee Corporation gas undertaking is now under the full control of Mr. Alex. Yuill. Hitherto he has been working out plans which were made by others; but now he is responsible for both the arrangements and the working. It is a matter which reflects credit on all concerned that, with things as they have been, such a good record has been shown. We must take it that, on the one hand, the arrangements made by Mr. Yuill's predecessors had been of a thoroughly satisfactory nature, and also that Mr. Yuill, in the working of them out, has shown a power of adapting himself to circumstances, and of making the most of things which come to his hand, which have been remarkable. It is not often that new arrangements bear fruit with the promptitude which has been found to be the case in Dundee. In seeking for a reason for this state of matters, it must be recognized that during last year the heating arrangements of the retort-bench were overhauled, and that only then did the works receive the full benefit which was contemplated when it was resolved to rebuild the retort-bench. On the other hand, it must not be forgotten that much of the success which has attended Mr. Yuill's first year of office in Dundee has been due to his introduction of the process of enrichment by benzol, in which matter he was not working out the idea of someone else. Then there was his own personal element, which was, perhaps, the biggest factor of all in bringing about the satisfactory state of matters which now exists. It is pleasing to note Treasurer Ritchie acknowledging the good qualities which Mr. Yuill has displayed, and to see, in his remarks, the thorough confidence which they have in him. But the undertaking is not yet out of the wood. They have adopted a new method of stating their accounts (which have all along been a very weak part of the economics of the city), and they have reduced the price of gas to a reasonable figure; but they have a stiff hill to climb before they can feel themselves secure from the disturbing influences of fluctuating markets. There is every reason to believe

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that this is quite realized, for the Treasurer expressed himself as against the price of gas being reduced beyond a certain limit; and he made reference to the long period—about forty years—of the operation of the sinking fund. With their minds thus set upon a definite policy, there is ground for the hope that they will be able to carry it successfully through. But it is a pity to see that there is not full support in the Council to the policy for which Treasurer Ritchie has striven, and has now obtained sanction to.

Thirty five years ago, the quantity of gas made in Dundee was 136 million cubic feet per annum; last year it was 665 million cubic feet. In the same period, the capital debt has risen from £256,000 to £426,000; but per million cubic feet of gas made, it has fallen from £1278 to £641. The price of gas was then 5s. 4d. per 1000 cubic feet; in 1874 it rose to 6s.; and it is now 3s. The annual income has risen from £43,000 to £122,000; and the annual expenditure from £27,000 to £89,000. The charges for annuities, sinking, and contingent funds, and interest, have fallen from 1s. 2·32d. to 8·76d. per 1000 feet.

In the Glasgow Town Council on Thursday, the recent purchase of 710,500 tons of coal for the gas undertaking was reported. Bailie Stewart thought it was an extraordinary quantity of coal to purchase; and he wished the Council to observe that they were practically in the hands of an immense combination in the coal trade, and had actually purchased 120,000 tons of coal from a Company whose object was to "corner" that coal, so far as Scotland was concerned. They were, he said, buying coal from one pit which Mr. Foulis had recommended the Commissioners to purchase for themselves. He asked the Council to consider that at a near date this Company might absorb all the coal-pits. On its being pointed out that no such recommendation had ever been before the Committee, Bailie Stewart said he referred to a remark which was made in Committee, which brought from Lord Provost Primrose the remark that they could not found on conversation; they could only deal with the minutes which were placed before the Council. The statement that Mr. Foulis had ever recommended the purchase of any coal-pit was denied by Mr. Paton, who also said that, so far from their getting into the hands of a big combination, there never was more competition than this year for their orders from people in all parts of Scotland. The number of competitors was simply enormous—so much so that the Committee had been able to buy coal cheaper than they had done for many years. Mr. Willoch, speaking as a member of the Committee, said that the prices for coal were a good deal better than last year; and he believed, from his knowledge, that there was every hope of a good year for the consumers of gas. The minutes of the Gas Committee were adopted.

The annual accounts of the Perth Gas-Works have been made up, and would have been submitted to the Town Council at a special meeting on Thursday; but the report of the Auditor had not come to hand, and so consideration of them was postponed. They show a total revenue of £32,068, of which there was derived from the sale of gas at 3s. 4d. per 1000 cubic feet, less £641 of discount, £27,388. The ordinary expenditure amounted to £21,765, which leaves a balance of £10,303. A balance of £1294 was brought forward from the previous year. The sinking fund has been increased from £1004 to £5580. Instalments have been paid on £52,500 of Corporation stock, to the amount of £525; and annuities have been redeemed to the extent of £1092. Annuities paid amounted to £2626, interest to £4543, and the deficit on the Electric Lighting Department to £117. A sum of £500 has been placed to contingency and depreciation account; and there is a balance left at the credit of the revenue account of £561. The debt upon the undertaking is £112,312. It is estimated that in the current year, with the price of gas reduced to 3s. 4d. per 1000 cubic feet for lighting, and a differential rate of 2s. 8d. established for gas for power purposes, there will be a total revenue of £33,001, and an expenditure of £32,554, which would leave a surplus of £447. Of the estimated expenditure, the principal item is £12,191 for coal.

The report of Messrs. Black and Strang, architects, of Falkirk, upon the suitability of the Parkhouse site for the erection of proposed new gas-works, the substance of which I gave in the "JOURNAL" a fortnight ago, was laid before the Town Council on Monday. They state that, having considered the sketch plans and tables of weights put before them by the Manager (Mr. J. Kincaid), and having had six pits dug to depths of from 4 to 10 feet, and finding them to verify the bores which were put down in 1899 and 1900, they were of opinion that, in its present state, the ground was most unsuitable for buildings of the weight proposed to be put upon it. They had also considered the best means of consolidating the soil—by piling certain parts of the ground—but had come to the conclusion that, apart from the very great cost of piling and preparing the site, there would still be heavy risk of subsidence, especially in the case of the retort-house, where the weights are not only greater, but are more unequally distributed. They therefore reported that, in their opinion, the site was not a suitable one for the proposed new works. The adoption of the report was moved by Mr. Neilson, whose pet project this site was, and who was mainly responsible for the Council throwing over the Thornhill site. He admitted that he expected the result might have been different; but he accepted it, as he thought they were bound to do, after remitting the matter to those gentlemen. The Council unanimously adopted the report, and discharged the special Committee at whose instance it was procured. No mention was made of any other proposal for new works, so that the whole question is for the present shelved.

An unfortunate accident occurred at the Arbroath Gas-Works at a quarter to six yesterday morning, in the fall of a large portion of the roof of the retort-house. There was, however, this amount of good fortune in the mishap—that the roof had been condemned, and that, occurring as the accident did at the time when the night shift were going off duty and the day shift had not arrived, there was no one in the place at the time, and thus none of the employees were injured. The part of the roof which fell extends to about 90 feet, and was of iron and slate. Several months ago, Mr. A. C. Young, the Manager, reported upon the dangerous condition of the roof; and he was authorized to have the portion over the retort bench strengthened with wooden beams. This was done; and the portion so strengthened is still standing. The roof was a very old one. The Gas Committee met

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WINDSOR ST. WORKS, BIRMINGHAM	2,000,000	KINGSTON, PA.	125,000	TONBRIDGE	300,000
SALTLEY WORKS, BIRMINGHAM	2,000,000	PETERBOROUGH, ONT.	250,000	STRETFORD	500,000
COLCHESTER	300,000	WILKESBARRE, PA.	750,000	OLDBURY	300,000
BIRKENHEAD	2,250,000	ST. CATHERINES (Second Contract)	250,000	TODMORDEN	500,000
SWINDON (New Swindon Gas Co.)	120,000	BUFFALO, N.Y.	2,000,000	SALTLEY, BIRMINGHAM (Third Contract)	2,000,000
SALTLEY, BIRMINGHAM (Second Contract)	2,000,000	WINNIPEG, MAN.	500,000	YORK (Second Contract)	750,000
WINDSOR ST., BIRMINGHAM (Second Contract)	2,000,000	COLCHESTER (Second Contract)	300,000	ROCHESTER (Second Contract)	500,000
HALIFAX	1,000,000	YORK	750,000	NEWPORT (MON.)	250,000
TORONTO	250,000	ROCHESTER	500,000	TOKIO, JAPAN	1,000,000
OTTAWA	250,000	KINGSTON, ONT.	300,000	PERNAMBUCO (Brazil)	125,000
LINDSAY (Remodelled)	25,000	CRYSTAL PALACE DISTRICT	2,000,000	MALTON	150,000
MONTREAL	500,000	DULUTH, MINN.	300,000	DULUTH, MINN. (Second Contract)	300,000
TORONTO (Second Contract Remodelled)	2,000,000	CATERHAM	150,000	BROCKVILLE (ONT.)	250,000
BELLEVILLE	250,000	LEICESTER	2,000,000	SMETHWICK	500,000
OTTAWA (Second Contract)	250,000	ENSCHEDE (HOLLAND)	150,000	GRAVESEND	300,000
BRANTFORD (Remodelled)	200,000	BUENOS AYRES (RIVER PLATE CO.)	700,000	NEWPORT MON. (Second Contract)	250,000
		BURNLEY	1,500,000	TORONTO (Third Contract)	750,000
		KINGSTON-ON-THAMES	1,750,000	TORONTO (Fourth Contract)	1,000,000

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yesterday, and resolved that the work of renewing the whole roof be proceeded with at once. They also agreed to heighten it from a little over 12 feet to 28 feet.

In consequence of the state of alarm which certain of the public men in Broughty Ferry have been thrown into by the persistent publication, in Dundee newspapers, of letters referring to the condition of the gas-works and the financial position of the undertaking, the Corporation asked Mr. W. R. Herring to report to them upon the state of matters. Mr. Herring visited Broughty Ferry last Saturday; and before he left he indicated his views. The Town Council met in private on Tuesday, to consider Mr. Herring's interim report. It has not been made public; but there has leaked out the view that he is dissatisfied with the condition of the recently erected retorts, and that he considers another class of coal should be used. It has also transpired that there is a deficit of £2200 upon last year's working. Provost Gray said it was evident there was an adverse influence at work; and he moved that the Gas Committee be superseded until the Council had received and disposed of Mr. Herring's report. This was agreed to—Mr. Christie, the Convener of the Gas Committee, alone dissenting. Mr. Christie's position is that the new plant, which was only inaugurated in December last, should have a longer trial; a Committee being appointed to verify results. The Council have certainly taken a drastic step; but to judge whether they are right or wrong we must wait till Mr. Herring's report is made public. I observe that the Bill to confirm a Provisional Order authorizing the Corporation to borrow the £25,000 necessary to meet the cost of the recent works has been reported to the House of Commons for third reading.

It is reported that the stokers in the Alloa Gas-Works made a demand for an increase of their wages from 4s. 6d. to 5s. per shift; and having been offered, as a compromise, 4s. 9d. per shift, they, on Wednesday, left their employment. The movement is dignified by having the name of "strike" applied to it; but it is scarcely of such magnitude as to be worthy of the designation, and more particularly so when it is announced that the work of attending to the retorts is being carried on by temporary hands.

The Bothwell and Uddingston Gas Company, Limited, had last year a revenue of £11,325, of which £6861 was derived from the sale of gas, £45 from the hire of stoves, £2521 from the sale of coke, £622 from tar, and £1139 from sulphate of ammonia. The expenditure amounted to £8665, of which £3140 was for coal, £127 for lime, and £775 for cartage. The surplus was £2660, to which was added a balance from last year of £856. The Directors have set aside £575 for depreciation; and they recommend payment of a dividend at the rate of 10 per cent., the addition of £350 to reserve fund (raising it to £803), and the carrying forward of £751. The quantity of coal carbonized was 10,120 tons, and of gas sold 47,010,400 cubic feet. The price was 2s. 11d. per 1000 cubic feet. Besides gas, there was a yield of 6072 tons of coke (of which 1185 tons were used in manufacture), 103,585 gallons of tar, and 101 tons of sulphate of ammonia.

The annual report by Mr. T. O'Neill, the Manager of the Dunbar Gas-Works, submitted to the Town Council at their last meeting, stated that during the year 1072 tons of coal, costing 18s. 6d. per ton, were carbonized. The average yield of gas per ton of coal was 9939 cubic feet—an increase of 18 cubic feet per ton over the previous year. The quantity sold was 9,492,000 cubic feet—a decrease of 195,000 feet. The price was retained at 4s. 2d. per 1000 cubic feet.

COAL TRADE REPORTS.

Lancashire Coal Trade.

Apart from occasional special low quotations where collieries have surplus output under load which it is necessary to move away promptly, a generally steady tone is being maintained with regard to prices for all descriptions of fuel in this district. Large users of the lower qualities of round coal and engine fuel report that they are unable to secure any appreciable concession in prices on forward contracts, and it would seem that quoted rates have about settled down to something like the minimum they are likely to touch. Representatives of collieries invariably declare that already on common round coals and slack it is very exceptional where pits are working at a profit. With regard to gas coals, the reduction previously reported of 3d., but more generally about 6d., per ton on last year's contract rates represents the basis upon which any further business has been put through; and the locomotive fuel contracts have for the most part now been concluded at 3d. under last year's prices. The general basis of prices remains practically unchanged from those given in our last report, averaging on gas coals from 8s. 3d. to 8s. 9d. for ordinary screened Wigan four-feet, with 9s. as a special price in some cases, about 9s. 3d. to 9s. 6d. for ordinary screened Wigan Arley, up to 9s. 9d. and 10s. for some of the best qualities at the pit. The lower qualities of round coal that are used for steam and forge purposes are occasionally cut low for prompt clearance sales, especially where shipping orders can be secured to take away quantities; and for these in some instances 8s. 9d. to 9s. per ton has been taken, with ordinary quotations ranging from 9s. 3d. and 9s. 6d. up to 10s. for special sorts delivered at the ports on the Mersey. For inland sales pit prices remain about 8s. 3d. to 8s. 9d. per ton for good ordinary descriptions of steam and forge coals. Common slacks are quoted at 4s. 3d. to 4s. 6d. per ton at the pit, medium sorts 5s. and 5s. 3d. up to 5s. 9d., best slacks 6s. 6d. to 6s. 9d., and some special qualities 7s. The house-fire coal trade is just now getting into the slackest season of the year; but as reductions in price would scarcely stimulate much increased demand, quoted rates are as a rule being maintained at about 14s. to 14s. 6d. per ton at the pit for best Wigan Arley, 11s. 6d. to 12s. 6d. for seconds Arley and Pemberton four-feet, and 9s. 6d. up to 10s. and 10s. 6d. for common house-fire sorts.

Northern Coal Trade.

There has been a steady demand for coal, which is being made brisk through the approach of the local holidays, which cause the shipments to be heavier. The steam coal collieries have had generally full work of late, and the output has been well taken up. The prices of

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best Northumbrian steam coals have been steady at from 10s. 7½d. to 10s. 9d. per ton f.o.b.; second-class coals are scarcely so brisk, and are from 8s. 9d. to 9s. 3d., while steam smalls are steady at about 5s. 9d.—the output of this class being well taken up for export at the present time. In the gas coal trade, there is a full demand for export, which makes up for the limited local consumption at the present time, and which has certainly steadied the rates. Durham gas coals are from 8s. 6d. to 9s. per ton f.o.b., according to quality, for occasional cargoes. Some local contracts are in the market, but are likely to be generally renewed with the collieries, at a fall of perhaps about 4d. per ton on the rates of a year ago. Coke prices are steady at from 12s. 6d. to 13s. per ton; and at some inland towns gas coke is a little dearer.

Scotch Coal Trade.

Trade remains dull, and without any brightening of prospects for the coalowner. It is with difficulty that prices are maintained. The Conciliation Board sat in Edinburgh on Saturday last, to consider the proposal of the masters to reduce the wages of the miners to the minimum sum allowable under the present agreement. The decision has not yet been given. The prices quoted are: Main 8s. to 8s. 3d. per ton f.o.b. Glasgow, ell 8s. 6d. to 10s., and splint 9s. 3d. to 9s. 6d. The shipments for the week amounted to 213,061 tons—a decrease of 3920 tons upon the previous week, but an increase of 3959 tons upon the corresponding week of last year. For the year to date, the total shipments have been 4,628,135 tons—an increase of 166,346 tons upon the same period of last year.

Burslem Gas Supply.—In introducing to the Burslem Town Council the statement relating to the past year's operations of the gas-works, the Chairman of the Gas Committee (Mr. Wade) said the output of gas was 212,665,000 cubic feet, as against 208,319,000 feet in the preceding twelve months. The expenditure was £33,488, as compared with £35,664; while the receipts amounted to £33,463, against £35,665. There was thus apparently a loss of £25 on the year's working; but it had to be remembered that no money was received for the lighting of the streets, which was equivalent to a gift of £2000. Besides this, a considerable amount was spent on Coronation illuminations, and an increased sum was paid on account of loans. Mr. Wade paid a tribute to the work of the Gas Engineer (Mr. Henry Peaty).

Coventry Corporation Gas Supply.—The highly satisfactory report on the past year's working of the Coventry Corporation Gas Department, presented to the last meeting of the City Council (*ante*, p. 681), evoked little discussion. Mr. R. A. Rotherham, the Chairman of the Gas Committee, dealt with their policy, and that of the Engineer (Mr. Fletcher W. Stevenson, M.Inst.C.E.), and said that, much as the Committee would have liked to hand over another £1000 in relief of the rates, as had been suggested, they felt it would be unwise to do so until the reserve fund had been raised to about £10,000. They recommended that out of the profits, which amounted to upwards of £4000, the sum of £2000 should be added to the reserve fund, £2000 to the district fund, and the balance carried forward. The report was unanimously adopted.

Southport Extension Scheme.—At a special meeting of the Southport Town Council on Thursday, the following resolution was passed, on the proposition of Mr. Travis, seconded by Mr. Foggitt: "That the recommendation of the Birkdale Negotiations Committee be adopted, and that accordingly the Committee be authorized to make a representation to the Local Government Board that it is desirable to extend the borough boundaries so as to include the township of Birkdale, and that the Committee be authorized to take the necessary steps to carry out the resolution." It was shown that Birkdale had been offered either a district rate of 2s. 6d.—2d. less than at present—or a guaranteed total rate of 3s. 4d. for ten years, with gas at the same charge as Southport. The statement was made that, taking the gas charges into consideration, a Birkdale resident has paid for the past six or seven years at least, and now pays, a rate of about 7d. in the pound more than his friend who lives within the borough boundaries. Reference was also made to the economy in costs that would follow from a joint administration of water, educational, and municipal matters; and Mr. E. Trounson (Deputy-Mayor and Chairman of the Gas Committee), said he hoped Birkdale would meet them and come to terms without calling in the aid of the Local Government Board.

A Prosperous Year at Hinckley.—The past year has been a most successful one for the Hinckley Gas-Works. Besides a net profit of £1351 having been realized, there was a reduction in price which represented a further £390. Out of the profits, £1100 has been devoted to paying for gas mains and meters. In moving the adoption of the balance-sheet at the last meeting, Mr. Wills said the thanks of the Council should be given to the Gas Manager (Mr. F. Lee) for the way in which the business had been transacted. It has been agreed that two lights shall be fixed in the houses of slot-meter consumers free of cost; and that a charge at the rate of 2d. per 1000 cubic feet shall be made for the maintenance of the pipes so put in.

Lewisham Borough Council and the Crystal Palace Gas Bill.—At the meeting of the Lewisham Borough Council last Wednesday, the Works Committee presented a report on the proceedings in the Committee of the House of Commons on the Bill of the Crystal Palace District Gas Company. In consequence of a statement by the Chairman of the Committee that they were of opinion that all manufacturers of gas for the public should be free to take advantage of scientific improvements, and that therefore they had come to the conclusion that opposing Counsel should address themselves to the question of price, and not to that of the illuminating power or purity of the gas, Counsel representing the London County Council and the Lewisham and Beckenham Borough Councils announced that they would not proceed further, so far as that Committee was concerned. Clauses were inserted in the Bill with reference (*inter alia*) to the provision of a new official testing-place at the Council's stoneyard. The Bill passed the third reading in the House of Commons on the 18th of May. The Works Committee were of opinion that the question of the purity and illuminating power of the gas was one of such grave importance, that they had directed the opposition to be continued in the House of Lords, provided the other opposing authorities decided on the same course.

Tenders for the £20,000 of the Wakefield Gas Company's 4½ per cent. preference stock, which were invited in our advertisement columns, were recently opened. The stock was over-applied for, and was allotted at prices ranging from £116 to £110 per cent.

It will be seen by an announcement which appears elsewhere that the Swansea Gas Company have instructed Messrs. John M. Leeder and Son to offer for sale, on the 7th prox., £35,000 of new ordinary 5 per cent. stock and £5000 of 4 per cent. perpetual debenture stock of the Company; being part of the additional capital authorized by the Act of 1898.

We have received a tastefully got-up list of some of the large dry gas-meters made by Messrs. George Glover and Co., Limited, of Chelsea, which gives some idea of the extensive business carried on by this well-known firm. The sizes included are from 200-light to 2000-light; and the booklet contains an interesting photograph of two of the last-named size, which are fitted with 12-inch connections.

The New Hygienic Stove Company, Limited (77,673), has been registered with a capital of £5000 in £1 shares, to acquire the business of the Hygienic Stove Company, Limited, of No. 254, High Holborn, W.C., patentees and manufacturers of, and dealers in, gas-cooking ranges, gas fires and stoves, boiling-burners, and other articles and appliances involving the use of gas, electricity, coal, or other fuel. There will be no initial public issue.

The Directors of the South Staffordshire Mond Gas Company have purchased from the executors of the late Mr. E. Fisher Smith, the Colton's Fold Estate, consisting of about 17 acres, adjoining the site of their central station at Dudley Port. The area of the land now owned by the Company is nearly 40 acres, and is bounded by the London and North-Western main line, the Birmingham Canal, and the main roads from Tipton to Wednesbury and from Dudley Port to Prince's End.

We learn that arrangements have been made with the entire Pennsylvania Railroad system to supply them with Pintsch gas, and that there are under construction gas plants at Philadelphia, Harrisburg, Altoona, and Pittsburg, which are expected to be in operation in about three months. The Pennsylvania Railroad is one of the largest systems in the United States, operating with their affiliated lines upwards of 10,000 miles of road, and having about 4500 passenger cars. In addition to the gas plants above mentioned, they will be supplied from the present plants at Jersey City, Camden, Buffalo, Columbus, Cincinnati, Chicago, and St. Louis.

WANTED, FOR SALE, CONTRACT, &c., ADVERTISEMENTS IN THIS WEEK'S "JOURNAL."

Situations Vacant.

AGENTS FOR FIRE CEMENT. No. 4051.
CLERK. Long Eaton Gas-Works.
FOREMAN GAS PLANT ERECTOR. No. 4052.
REPRESENTATIVE, ENGINEERING FIRM. No. 4050.
SALESMAN, GAS FITTINGS, &c. Birmingham Gas Department. June 30.
SLOT-METER INSPECTOR AND COLLECTOR. Long Eaton Gas-Works.
TRAVELLER, GAS-STOVES. John Wright and Co., Birmingham.
WORKING MANAGER (Ireland). Anderson, Westminster.
WORKS FITTER. No. 4053.

Situations Wanted.

DRAUGHTSMAN OR REPRESENTATIVE, &c. No. 4046.
REPRESENTATIVE GAS ENGINEERING FIRM. No. 4045.

Capitalist Wanted. No. 4054.

Plant, &c., for Sale.

MOUTHPIECES AND VALVES. Staines Gas Company.
PURIFIERS, &c. Leighton Buzzard Gas-Works.
STATION METER. Cannock and Hednesford Gas-Works.

Sales of Stocks and Shares.

CROYDON GAS COMPANY. July 9.
HARWICH GAS COMPANY. July 6.
SOUTH ESSEX WATER COMPANY. July 14.
SWANSEA GAS COMPANY. July 7.
TENDRING HUNDRED WATER COMPANY. July 6.

TENDERS FOR

Benzol.

DARWEN GAS DEPARTMENT. Tenders by June 27.

Brass and Gun Metal Fittings, &c.

SALFORD GAS DEPARTMENT. Tenders by July 9.

Coal and Cannel.

BATLEY GAS DEPARTMENT. Tenders by July 4.
BETHESDA GAS DEPARTMENT. Tenders by July 7.
BOSTON GAS COMPANY. Tenders by June 27.
CARLISLE GAS DEPARTMENT. Tenders by June 30.
COALVILLE GAS DEPARTMENT. Tenders by July 11.
HAWORTH GAS DEPARTMENT. Tenders by July 2.
HEXHAM GAS COMPANY. Tenders by July 6.
ILKESTON GAS DEPARTMENT. Tenders by July 7.
LEEK GAS DEPARTMENT. Tenders by June 27.
LIMERICK GAS DEPARTMENT. Tenders by July 7.
MARKET HARBOROUGH GAS DEPARTMENT. Tenders by June 27.
OLDBURY GAS DEPARTMENT. Tenders by July 3.
SALISBURY GAS COMPANY. Tenders by June 30.
WOOLTON GAS COMPANY. Tenders by July 13.

Fire-Clay Goods.

DARWEN GAS DEPARTMENT. Tenders by June 27.

General Stores, Lead Pipe, Oils, Paints, &c.

SALFORD GAS DEPARTMENT. Tenders by July 9.

Iron and Steel.

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Meters and Meter Fittings.

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Pipes and Fittings, &c.

DARWEN GAS DEPARTMENT. Tenders by June 27.
SALFORD GAS DEPARTMENT. Tenders by July 9.

Retorts.

BANGOR GAS DEPARTMENT. Tenders by July 6.
DARWEN GAS DEPARTMENT. Tenders by June 27.

Tar and Ammoniacal Liquor.

ALTRINCHAM GAS COMPANY. Tenders by July 7.
CARLISLE GAS DEPARTMENT. Tenders by June 30.
GUILDFORD GAS COMPANY. Tenders by June 25.
KESWICK GAS COMPANY. Tenders by June 24.
LEEK GAS DEPARTMENT. Tenders by June 27.
SLEAFORD GAS COMPANY.

Weighing Machines (Testing and Repairing).

SALFORD GAS DEPARTMENT. Tenders by July 9.

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TENDERS are invited for 1000 to 4000 Tons of GAS COAL, delivered f.o.r. Salisbury, as required over the ensuing Twelve Months.
Monthly Payments.
Tenders to be sent on or before the 30th inst. to N. H. HUMPHRYS, Gas-Works, SALISBURY.

CITY OF CARLISLE.

THE Carlisle Gas Committee are pre- pared to receive TENDERS for the purchase of the Surplus TAR to be produced at their Works during the Nine Months ending March 25, 1904.
Tenders, endorsed "Tar," and addressed to the Chairman of the Gas Committee, to be delivered at the Office of the Town Clerk, not later than June 30, 1903.
Further Particulars can be obtained on application.
By order,
W. J. SMITH,
Engineer and General Manager.
Gas-Works, Carlisle,
June 10, 1903.

CITY OF CARLISLE.

THE Carlisle Gas Committee are pre- pared to receive TENDERS for the COAL and CANNEL required at their Works during One Year from the 1st of July next.
Tenders, endorsed "Coal," and addressed to the Chairman of the Gas Committee, to be delivered at the Office of the Town Clerk, not later than June 30, 1903.
Forms of Tender and other Particulars may be had on application to the undersigned.
By order,
W. J. SMITH,
Engineer and General Manager.
Gas-Works, Carlisle,
June 10, 1903.

LEEK URBAN DISTRICT COUNCIL.

TO COLLIERY PROPRIETORS AND OTHERS.

TENDERS are invited for the Supply of all or any portion of Best Washed NUTS and BEANS required at the Leek Gas-Works during the year ending the 30th of June, 1904, delivered at the North Staffordshire Railway Station.
Annual consumption, 8000 to 9000 Tons.
Forms of Tender and Further Particulars may be obtained from the undersigned.
Endorsed Tenders, addressed to the Chairman of the Gas Committee, to be delivered at the Town Hall, Leek, on or before Saturday, June 27 inst.
The lowest or any Tenders will not necessarily be accepted.
By order,
C. HENSHAW,
Clerk.
Town Hall, Leek,
June 10, 1903.

LEEK URBAN DISTRICT COUNCIL.

TO TAR DISTILLERS AND OTHERS.

TENDERS are invited for the Purchase of the SURPLUS GAS TAR and AMMONIACAL LIQUOR produced at the Leek Gas-Works for One, Two, or Three Years from the 1st of July, 1903, at per ton of 2240 lbs. at such works.
Endorsed Tenders, addressed to the Chairman of the Gas Committee, to be delivered at the Town Hall, Leek, on or before Saturday, the 27th of June inst.
Forms of Tender and further Particulars may be obtained from the undersigned.
The highest or any Tender will not necessarily be accepted.
By order,
C. HENSHAW,
Clerk.
Town Hall, Leek,
June 10, 1903.

BOROUGH OF DARWEN.

THE Gas Committee of the above Cor- poration are prepared to receive TENDERS for the supply of the following Goods for One Year:—
(1)—BENZOL.
(2)—WROUGHT-IRON TUBES and FITTINGS.
(3)—FIRE-CLAY, RETORTS, BRICKS, &c.
Further Particulars and Form of Tender may be obtained on application to Mr. A. H. Smith, Gas Engineer, Darwen.
Sealed and endorsed Tenders must be delivered to the undersigned not later than Saturday, the 27th day of June.
The Committee do not bind themselves to accept the lowest or any Tender.
By order,
WILLIAM P. HALLIWELL,
Town Clerk.
Town Clerk's Office,
June 8, 1903.

TENDERS FOR TAR AND LIQUOR.

THE Sleaford Gas Company, Limited, invite TENDERS for their surplus TAR and AMMONIACAL LIQUOR for One Year. Will be loaded into Contractors' Tank-Waggons at Sleaford Station.
Forms of Tender to be obtained from the undersigned.
By order,
H. WIMHURST,
Engineer and Manager.

BOSTON GASLIGHT AND COKE COMPANY.

THE Directors of the above Company invite TENDERS for the supply of from 1000 to 6000 Tons of Best Screened South Yorkshire Silkstone GAS COAL.
Delivery free into our Siding (G.N. Railway, Boston) in such quantities, and at such times, as desired between the 1st of July, 1903, and the 30th of June, 1904, or at any shorter period between the above dates, if so desired.
The lowest or any Tender will not necessarily be accepted.
Tenders to be delivered to me not later than Saturday, June 27, 1903.
J. STEWART DOUGALL,
Manager.
Gas Offices, Boston,
June 19, 1903.

THE WOOLTON GAS COMPANY.

THE Directors invite Tenders for the supply of about 1600 Tons of GAS COAL and 400 Tons of CANNEL, to be well screened, free from Shale and Pyrites, and delivered at Allerton Sidings (Cheshire Lines) between the 1st of August next, and the 31st of July, 1904, in such quantities as may from time to time be required.
Tenders, accompanied by Analyses, to be sent in to the undersigned not later than July 13, 1903.
The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right to divide the quantity.
W. E. ROBERTS,
Manager and Secretary.
Gas-Works, Woolton,
near Liverpool.
June 19, 1903.

STAINES AND EGHAM GAS COMPANY, LIMITED.

GAS PLANT FOR SALE.

THE Directors of the above Company invite OFFERS for the following:—

84	MOUTHPIECES	20in. by 13in.
24	"	22in. by 16in.
12	"	22in. by 16in. Tangye's Patent.
12	"	20in. by 13in. Holman's Patent.
4	10-inch HYDRAULIC VALVES.	

Further Particulars can be obtained of Mr. T. Webb, Manager, Gas-Works, near Staines.
Sealed Tenders to be sent in to me on or before Wednesday, the 1st of July next.
GEO. H. SAYERS,
Secretary.
Gas Offices, Egham Causeway,
Near Staines, June 18, 1903.

BOROUGH OF BATLEY.

TENDERS FOR GAS COAL.

THE Corporation of Batley are prepared to receive TENDERS for the supply and delivery at their Gas-Works of 18,000 Tons of screened GAS COAL.
Conditions and Forms of Tender may be obtained on application to the Manager of the Gas-Works.
Sealed Tenders, addressed to me, and endorsed "Gas Coal," to be delivered at my Office by noon on Saturday, the 4th day of July prox.
The Corporation do not bind themselves to accept the lowest or any Tender, and may accept any Tender for a part only of the specified quantity.
By order,
JOSEPH HANSON CRAIK,
Town Clerk.
Town Clerk's Office, Batley,
June 19, 1903.

COUNTY BOROUGH OF SALFORD.
(GAS DEPARTMENT.)

GENERAL STORES.

THE Gas Committee invite Tenders for the following MATERIAL, in such quantities as may be required during the Twelve Months ending the 31st of August, 1904.
1—Wrought Iron and Steel.
2—Lead Pipe, Block Tin Tubing, Pendants, and Glass.
3—Bolts, Nuts, Rivets, and Washers.
4—Iron Castings, &c.
5—Gun Metal Taps and Keys, and Brass Lamp Taps.
6—Wrought-Iron Steam and Gas Tubing, and Sundry Fittings.
7—Gas-Meters.
8—Paints, Red and White Lead.
9—Oils and Tallow.
10—Timber.
11—Rope, Yarn, and Twine.
12—Brushes.
13—Testing, and Repairing Weighing-Machines.
14—Brass Fittings for Meters.
15—India-Rubber Rings, Tubing, and Sheeting.
16—Cast-Iron Main Pipes.
Forms of Tender and all Information may be obtained, and samples seen, on application to Mr. Wm. W. Woodward, Engineer, Bloom Street, Salford.
Sealed Tenders, endorsed "Tender for Stores," addressed to the Chairman of the Gas Committee, Town Hall, Salford, to be delivered to me not later than Three p.m. on Thursday, the 9th of July, 1903.
L. C. EVANS,
Town Clerk.
Town Hall, Salford,
June 18, 1903.

CORPORATION OF ILKESTON.
(GAS DEPARTMENT.)

TENDERS FOR GAS COAL.

THE Gas Committee invite Tenders for 10,000 Tons of GAS COAL, NUTS or CANNEL, to be delivered at the Gas-Works Siding (Midland Rly.).
The Tenders must be on the usual Form to be obtained at the Gas Offices, and be endorsed "Coal," and sent to Wright Lissett, Esq., Town Clerk, not later than July 7, 1903.
The Committee do not pledge themselves to accept the lowest or any Tender, and reserve their right to divide the quantity.
F. C. HUMPHRYS,
Engineer and Manager.
Gas-Works, Ilkeston,
June 19, 1903.

COALVILLE URBAN DISTRICT COUNCIL.
(GAS DEPARTMENT.)

THE above Council invite Tenders for the supply of 1500 Tons of GAS COAL or NUTS delivered in Waggons to Coalville (Midland Railway) between July 1, 1903, and June 30, 1904, in such quantities, monthly, as required.
The Council reserve the right to divide the quantity.
The lowest or any Tender not necessarily accepted.
Tenders, endorsed "Coal," addressed to the Chairman of the Gas Committee, to be delivered at the Gas Office, Whitwick, Leicestershire, on or before July 11, 1903.
No Forms supplied.
JOS. W. EAGLES,
Manager.
Gas-Works, Whitwick,
June 19, 1903.

GAS COAL.

THE Bethesda Urban District Council are prepared to receive TENDERS for the GAS COAL required at their Gas-Works during the ensuing Year, in such quantities and at such times as may be required (in all about 300 Tons) from the 1st of August, 1903, to the 31st of July, 1904.
Tenders to state price per Ton and be accompanied by an Analysis of the Coal.
The person whose Tender is accepted will be required to enter into an agreement with the Council for the due performance of his contract.
The lowest or any Tender not necessarily accepted.
The Tenders to be sent in on or before the 7th day of July, 1903.
D. GRIFFITH DAVIES,
Clerk and Solicitor.
Council Offices, Bethesda,
June 16, 1903.

GUILDFORD GASLIGHT AND COKE COMPANY.

TO TAR DISTILLERS.

THE Directors of the above Company are prepared to receive TENDERS for the surplus COAL GAS TAR and Carburetted WATER GAS TAR, separately or mixed, produced by the above Company, for the Year ending the 30th of June, 1904.
Coal carbonized, about 11,000 Tons per annum.
All Tenders to state the price per cask of 40 gallons.
Cartage to and from Railway Station, Guildford, free.
All empties to be provided by Contractor.
Tenders, endorsed "Tar," to be sent to William Baker, Esq., J.P., C.C., Vice-Chairman of the Gas Company, Guildford, on or before Wednesday, June 25, 1903.
By Order,
WILLIAM TITLEY,
Secretary.
Gas Offices, Guildford,
June 13, 1903.

ALTRINCHAM GAS COMPANY.

TENDERS FOR TAR.

THE Directors of the above Company invite TENDERS for the surplus TAR produced at their Works between the 1st of July next and the 30th of June, 1904.
Estimated Quantity, 900 Tons.
Delivery into Contractor's or Gas Company's Tank-Waggons at Altrincham Station or in Contractor's Barrel Carts at the Gas-Works.
Sealed Tenders, addressed to the Chairman and endorsed "Tender for Tar," to be delivered not later than Tuesday, the 7th of July.
The Directors do not bind themselves to accept the highest or any Tender.
J. E. LAMB,
Manager.
Gas Offices, Altrincham,
June 16, 1903.

URBAN DISTRICT COUNCIL OF OLDBURY.
(GAS DEPARTMENT.)

THE Gas Committee of the above Council are prepared to receive TENDERS for the supply of 12,000 Tons (or thereabouts) of Screened GAS COAL for delivery during the Year ending June 30, 1904, in such quantities and at such times as ordered, Carriage free, at the (1) Oldbury Basin Great Western Railway, and (2) London and North-Western Railway, Oldbury.
Sealed Tenders, addressed to the Chairman of the Gas Committee and endorsed "Tender for Gas Coal," must be delivered to the undersigned not later than Friday morning, July 3 next.
The Gas Committee do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right to apportion the whole quantity as they may think fit.
Tender Forms and any further Information may be obtained from the undersigned on application in writing.
By order,
A. COOKE,
General Manager.
Gas-Works, Oldbury,
June 16, 1903.

TAR Contracts Wanted on the Sliding-Scale or at Fixed Prices.

Managers and Secretaries desirous of selling to best advantage please communicate with DENT AND CO., Ouse Chemical Works, SELBY.

TENDERS FOR GAS COAL.

THE Gas Committee of Limerick invite TENDERS, on or before the 7th of July, for 8000 or 17,000 Tons of GAS COAL, according to specification to be had on application at the GAS OFFICES, 34 and 35, William Street, LIMERICK.

June 13, 1903.

THE Directors of the Keswick Gas Company invite TENDERS for their Surplus TAR and AMMONIACAL LIQUOR for Twelve Months from the 30th inst., at per ton, delivered into Contractors' Tanks at Keswick Railway Station.

Sealed Tenders, endorsed "Tender for Tar" or "Liquor," will be received by the undersigned on or before Wednesday, the 24th inst.; but the Directors do not bind themselves to accept the highest or any Tender.

J. H. BRODIE,
Secretary.

Main Street, Keswick,
Cumberland, June 10, 1903.

THE Haworth Urban District Council are prepared to receive TENDERS for the supply of 2500 Tons of Screened or Unscreened GAS COAL, delivered during the ensuing Twelve Months on rails at Haworth Station.

Sealed Tenders to be sent to me, the undersigned, marked "Tender for Coal," not later than the 2nd of July next.

WILLIAM ROBERTSHAW,
Clerk to the Council.

North Street,
Keighley.

URBAN DISTRICT OF BANGOR, CO. DOWN.

THE Council of the above Urban District invite TENDERS for the Re-setting, &c., of Two Beds of RETORTS at their Gas-Works.

Drawings and Specification can be seen on application to the Gas Manager, Gas-Works, Bangor, Co. Down.

Tenders will be received by me up till Twelve o'clock noon on the 6th of July next.

A Bond will be required to be entered into with approved security for the due performance of the work.

The lowest or any Tender not necessarily accepted.

JAS. MILLIKEN,
Clerk to the Council.

Town Hall, Bangor, Co. Down,
June 17, 1903.

ISSUES BY AUCTION OF GAS AND WATER STOCKS AND SHARES.

MR. ALFRED RICHARDS begs to notify that his ISSUES by AUCTION under PARLIAMENTARY POWERS of STOCKS and SHARES in LONDON, SUBURBAN, and PROVINCIAL GAS and WATER COMPANIES take place PERIODICALLY at the Mart, TOKENHOUSE YARD, E.C.

Terms for Issuing such Capital, and also for including Gas and Water Stocks and Shares belonging to Private Owners in these Periodical Sales, can be obtained on application at Mr. ALFRED RICHARDS' OFFICES, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the

HARWICH GAS AND COKE COMPANY.

NEW ISSUE OF 500 £5 ADDITIONAL SHARES.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, E.C., on Monday, July 6, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

TENDRING HUNDRED WATER-WORKS COMPANY.

(Incorporated in 1884), supplying Harwich, Parkeston, and the East Coast Resorts of Dovercourt, Walton-on-Naze, and Frinton-on-Sea, &c.

SALE BY AUCTION OF 500 £10 "A" SHARES.

Ranking up to 8 per cent. Dividend equally with the existing "A" Shares, which have received 4½ per cent. for the last Six Years.

The Water Revenue has risen from £3900 in 1897 to £6638 at the present time; and this new Capital is required for Works necessitated by the increasing demand for Water, the result of the continued development of the district.

MR. ALFRED RICHARDS will Issue the ABOVE BY AUCTION, at the Mart, London, E.C., on Monday, July 6, 1903, at Two o'clock, in Lots, by order of the Directors.

Particulars of Sale, with Form of Instructions for the Auctioneer or Secretary to purchase for Investors unable to attend the Auction, obtainable post free of the SECRETARY of the Company, MISTLEY, ESSEX, or of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the

SOUTH ESSEX WATER-WORKS COMPANY.

NEW ISSUE OF £9750 FOUR PER CENT. PERPETUAL DEBENTURE STOCK.

MR. ALFRED RICHARDS will Sell the ABOVE BY AUCTION, at the Mart, Tokenhouse Yard, E.C., on Tuesday, July 14, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By Order of the Directors of the

CROYDON COMMERCIAL GAS AND COKE COMPANY.

SALE OF £2500 FIVE PER CENT. PERPETUAL DEBENTURE STOCK AND £5000 CONSOLIDATED "C" ORDINARY STOCK.

MESSRS. HOOKER and WEBB have received instructions to SELL BY AUCTION, at the Greyhound Hotel, Croydon, on Thursday, the 9th of July, at Six o'clock precisely, in Lots to suit buyers of large or small quantities, £5000 CONSOLIDATED "C" ORDINARY STOCK and £2500 FIVE PER CENT. PERPETUAL DEBENTURE STOCK of the Croydon Commercial Gas and Coke Company. The Dividends paid on the "C" Stock for some years have been at the rate of Nine per Cent. per annum, and since 1898 have been paid free of Income-Tax. The Reserve and Insurance Fund now amounts to £45,056 0s. 9d.

Particulars and Conditions of Sale may be had of the SECRETARY, at the Offices of the Company, Katharine Street, CROYDON; at the place of Sale; and of the AUCTIONEERS, 4, High Street, CROYDON. Telephone, No. 122.

COUNTY BOROUGH OF SWANSEA,
SOUTH WALES.

By Order of the Directors of
THE SWANSEA GASLIGHT COMPANY.

MESSRS. JOHN M. LEEDER & SON have received instructions to offer for SALE BY PUBLIC AUCTION, at the Hotel Métropole, Swansea, on Tuesday, July 7, 1903, at 2.30 for 3 o'clock, p.m., precisely.

£35,000 NEW ORDINARY STOCK

(Entitled to 5 per cent. per annum Interest), and

£5000 FOUR PER CENT. PERPETUAL DEBENTURE STOCK

OF AND IN

THE SWANSEA GASLIGHT COMPANY,

Being part of the Additional Capital of the Company authorized to be raised by the Swansea Gas Act, 1898, and pursuant to the Provisions and Conditions therein contained.

Purchasers of the New Ordinary Stock, 1898, will be entitled to six Months Interest (at 5 per cent. per annum), free of Income-Tax, as from the 1st of July, 1903, payable on the 1st of April, 1904; and purchasers of the 4 per cent. Perpetual Debenture Stock, 1898, to Six Months' Interest due and payable on the 1st of January, 1904.

Particulars and Conditions of Sale, containing all necessary Information, may be obtained on application to THORNTON ANDREWS, Esq., Secretary and Manager of the Swansea Gaslight Company, Oystermouth Road, SWANSEA, and at the AUCTIONEERS' OFFICES, 46, Waterloo Street, SWANSEA.

THE

PETROLEUM GAS SYNDICATE

Supply and erect Complete Installations of their

PETROGENE PATENT GAS PLANT

On SALE, HIRE, or ROYALTY.

PETROGENE GAS is the most suitable Illuminant for all Towns, Villages, Factories, Institutions, &c., where a Cheap and Efficient Lighting System is required. It is equally suitable for Heating and Power purposes, and may be used with ordinary Gas Fittings, Stoves, Engines, &c. It may also be used in conjunction with Coal Gas, and affords Gas Companies a ready means of increasing their output without the expense of additional storage.

The Syndicate is prepared to entertain offers of sale of small Gas-Works, whether profit earning or not.

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Above the Average in Weight and Quality of Coke.
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Manufacture and keep in Stock at their Works (also large stock in London)

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FOR
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For use in the
RECOVERY OF SULPHUR,
Also Removal of last Traces of
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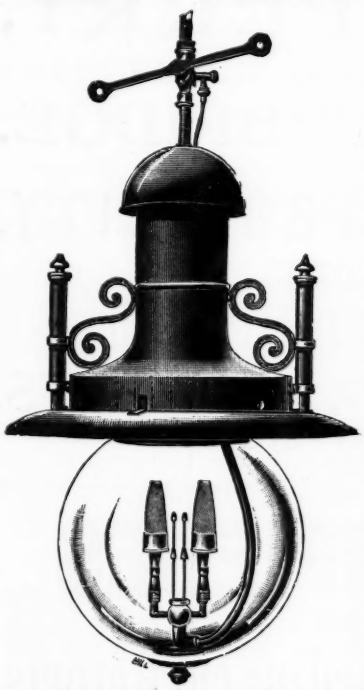

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Cost from £3 10s. to £12 10s. "A" size replaces 25 men.

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Highest Results in Gas, & Excellent Coke.
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NEWBATTLE COLLIERIES,
DALKEITH, N.B.

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SILICA BLOCKS, BRICKS, AND CEMENT
OF SUPERIOR QUALITY
FOR GAS-FURNACES.
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These Goods (largely used in Gas, Glass, Iron, and Steel Works) are, on account of their
GREATER DURABILITY,
Strongly recommended where EXCESSIVE HEATS have to be maintained.

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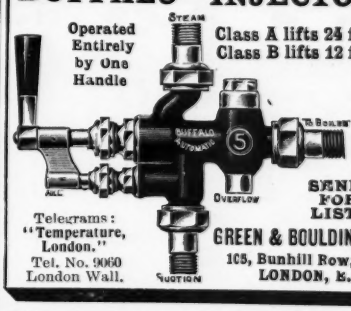

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Applications for Colonial & Foreign Agencies invited.
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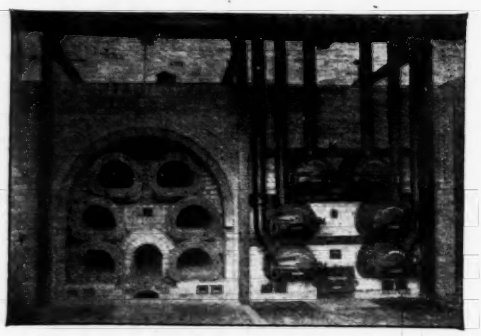

PHOTO. OF REGENERATOR SETTINGS DURING CONSTRUCTION.

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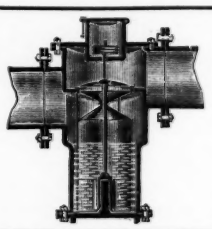

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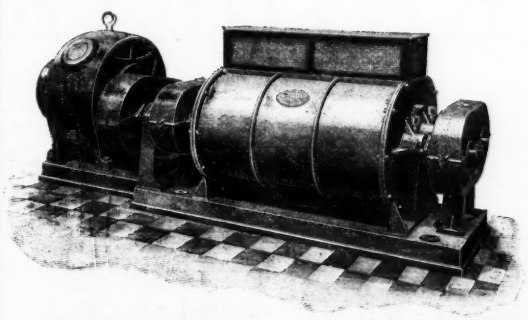

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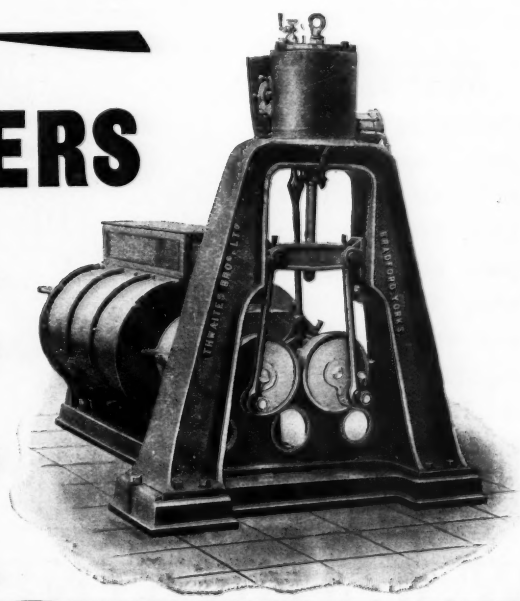

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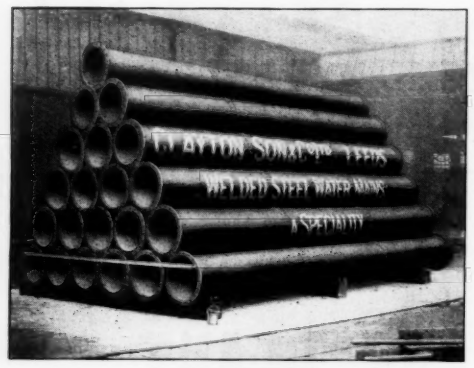

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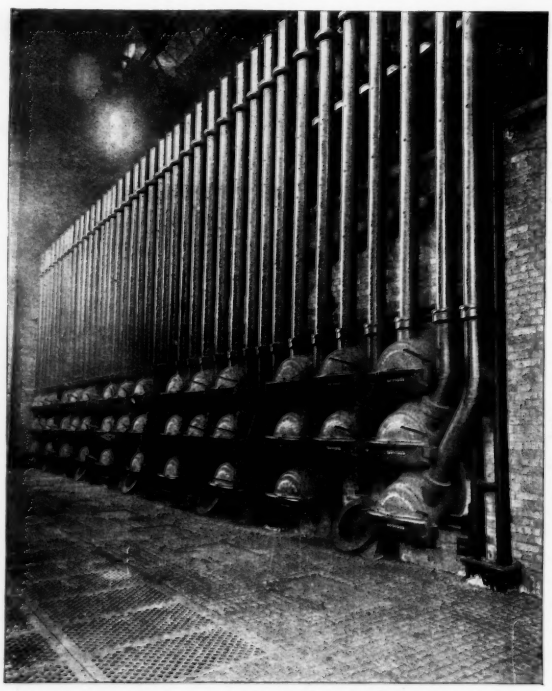

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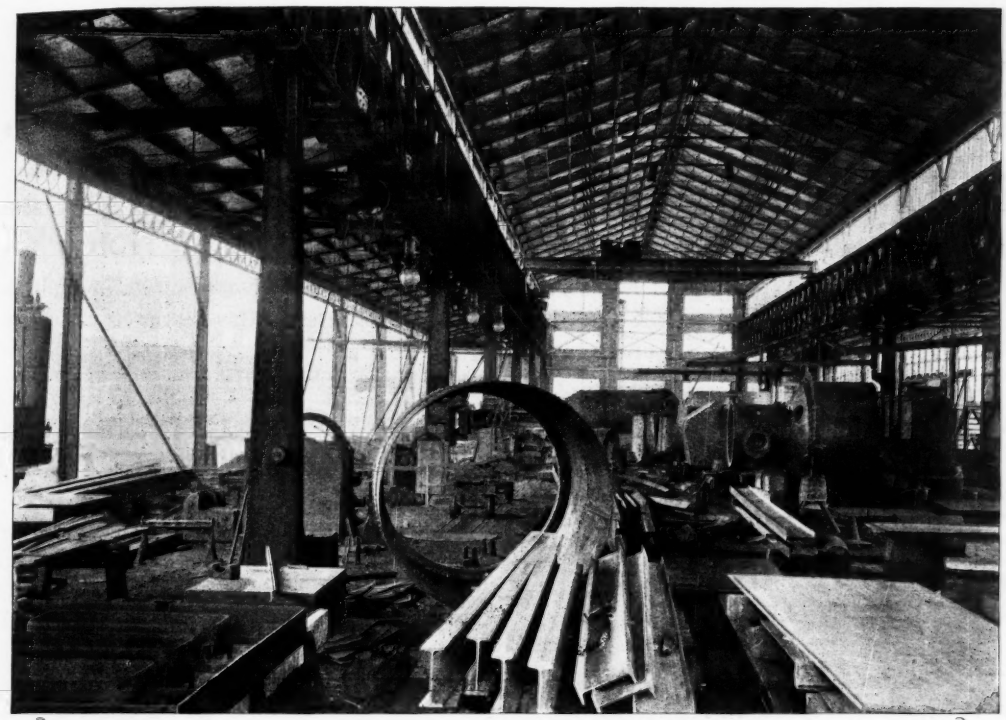

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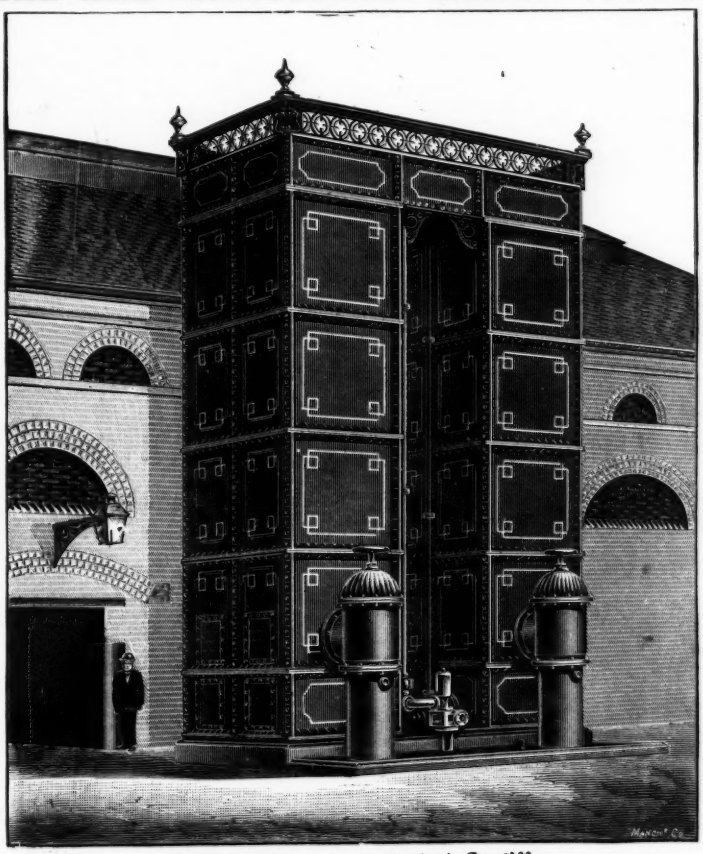

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